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VOL. CXLI.—No. 3667] LONDON: FRIDAY EVENING, APRIL 9, 1926 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

The Director - General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for :—
1. STEEL FISH BOLTS, NUTS and WASHERS.
2. STEEL BRIDGE WORK.
Tenders due on the 20th April, 1926, for No. 1, and on the 5th May, 1926, for No. 2.
Tender forms obtainable from the above. 2111

Assistant Engineers (2) REQUIRED by the GOVERNMENT of UGANDA for the PUBLIC WORKS DEPARTMENT for a tour of 20 to 30 months' service, with possible extension. Salary £400, rising to £600 a year, plus a temporary local allowance. Outfit allowance of £30 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, aged 25 to 30, must be A.M.I.C.E. or hold equivalent professional qualifications, and preferably have received training and experience in a Municipal Engineer's office. Must possess a sound knowledge of building and road construction. —Apply at once by letter, stating age, qualifications and particulars of experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, S.W. 1, quoting M/14296. 2110

G. R.

For Sale by Tender, Closing TUESDAY 27th APRIL, at 11 a.m.,
GENERATING PLANT
At Princess Mary's Convalescent Centre, Rednal, Birmingham, comprising :—
A 90 H.P. SIX-CYLINDER "PARSONS" PETROL-PARAFFIN ENGINE coupled to DYNAMO, by Electric Construction Co., Ltd., 50 K.W., 220 volts, 228 amps., with Four Galvanised Iron Cooling Tanks, Petrol Tank and Paraffin Supply Tanks, with Double Booster Set, including Switchboard with Automatic Main Trip Switch, Amp., Volt and Consumption Meters, and Control Switches and Battery Charging Board and 120 Storage Batteries.
Forms of Tender can be obtained from the CONTROLLER of SUPPLIES, H.M. Office of Works, King Charles-street London, S.W.; or of the DISTRICT ENGINEER, H.M. Office of Works, 42, Paradise-street, Birmingham. 2087

ARMSTRONG COLLEGE,
NEWCASTLE-UPON-TYNE
(In the University of Durham).

Courses for the Pass Degree of B.Sc (3 years) and the Honours Degree of B.Sc. (4 years) in Mechanical, Marine, Civil or Electrical Engineering, Mining, Metallurgy or Naval Architecture. Composition (tuition) fee: £40 per annum.

Other Courses for Pure Science, Arts, Commerce, Law, Agriculture and Fine Art.

Full particulars on application to:
REGISTRAR,
Armstrong College,
Newcastle-upon-Tyne.
1906

University of Liverpool.
FACULTY OF ENGINEERING.

DEAN: Professor C. O. BANNISTER, M.Eng., Assoc. R.S.M., F.I.C., M. Inst. M.M.
The University awards the Degrees of B.Eng., M.Eng., D.Eng., Ph.D., and a Certificate and Diploma in Engineering.
Degree Candidates must pass an approved Matriculation Examination. Certificate Candidates must submit evidence of having received a good general education. Diploma Candidates must possess the Certificate in Engineering.
The Courses are designed for students desiring to qualify as MECHANICAL, ELECTRICAL, CIVIL or MARINE ENGINEERS, as NAVAL ARCHITECTS and METALLURGISTS or METALLURGICAL ENGINEERS. The Courses cover the subjects of examination for Associate Membership of the Institutions of Civil, Mechanical and Electrical Engineers. The Institutions named, subject to certain conditions, accept the Degree of B.Eng. in lieu of part, and in some cases the whole, of the examinations for Associate Membership. The various Departments are housed in commodious and well-equipped buildings, and provide ample facilities for research.
A prospectus of the Faculty, giving particulars of Courses and a large number of Entrance and Post-graduate Scholarships, may be had on application to the undersigned.
EDWARD CAREY,
2090 Registrar.

TENDERS INVITED.

The County of London Electric SUPPLY CO., LTD.
BARKING POWER STATION EXTENSIONS, 1926.
The County of London Electric Supply Company, Ltd., are open to receive TENDERS for the SUPPLY and ERECTION of COAL UNLOADING, STORING, and RECLAIMING PLANT at their Barking Power Station.
Specifications may be obtained by manufacturers from the offices of the Company on application to the undersigned on or after April 13th, 1926, on payment of a fee of £5 5s. for the first copy and £2 2s. for every subsequent copy.
Sealed Tenders, marked "Tender for Coal Unloading, Storing and Reclaiming Plant," should be addressed to the undersigned and lodged at the registered office of the Company by Noon on the 10th May, 1926.
Sums paid for any number of copies up to three will be refunded on receipt of a bona fide Tender.
The Company do not bind themselves to accept the lowest or any Tender.
F. C. McQUOWN,
Joint Manager and Secretary.
The County of London Electric Supply Co., Ltd.,
Moorgate-court, Moorgate-place,
London, E.C. 2. 2109

The Engineer

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PUBLIC NOTICES

Bradford Education Committee.
TECHNICAL COLLEGE.
APPLICATIONS are INVITED for the APPOINTMENT of LECTURER in the Department of Electrical Engineering in the College.
Salary according to Burnham Technical Award.
Candidates should preferably possess special qualifications in High Frequency and Thermionic Work.
Full particulars of the appointment and forms of application may be obtained from the Principal of the College, to whom the completed application should be returned not later than 21st April, 1926.
2066 N. L. FLEMING, Town Clerk.

City of Birmingham.
WATER DEPARTMENT.
SALE OF PUMPING MACHINERY.
TENDERS are INVITED for the PURCHASE, DISMANTLING and REMOVAL of PUMPING MACHINERY, BOILERS, &c., at Selly Oak Pumping Station, near Birmingham, comprising :—
One 60 H.P. Cornish Pumping Engine, manufactured by Messrs. James Watt and Co., of Soho ;
Two Lancashire Boilers (old), Steam Pipes, &c.
Full particulars, together with form of Tender and permit to view, may be had on application to the undersigned.
J. H. BROADLEY,
Secretary.
Water Department,
Council House, Birmingham,
6th April, 1926. 2086

County Borough of Dublin.
TENDERS FOR MECHANICAL WATER FILTERS.
The Dublin Borough Commissioners request TENDERS for MECHANICAL FILTERS capable of filtering five million gallons per 24 hours, to be erected close to the existing filters at Roundwood, Co. Wicklow.
Full particulars and conditions may be obtained on application to the Acting Borough Surveyor, 28, Castle-street, Dublin, on lodgment with him of the sum of One Guinea, which will be refunded on receipt of a bona fide Tender.
Sealed Tenders, endorsed "Tender for Mechanical Filters," should be addressed to the Dublin Borough Commissioners and delivered at the office of the Waterworks and Markets Section, 28, Castle-street, Dublin, on or before Monday, 26th April, 1926.
JOHN J. MURPHY,
Town Clerk.
City Hall, Dublin,
31st March, 1926. 2089

PUBLIC NOTICES

B. B. & C.I. Railway Company. The Directors are prepared to receive up to Noon on Friday, 23rd April, TENDERS for the SUPPLY of—
1. STEEL MATERIAL (M.S. Sections, Plates and Bars, &c.).
2. LEATHER BELTING, &c.
Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 20s. each for No. 1 and 10s. each for No. 2 (which will not be returned).
The Directors do not bind themselves to accept the lowest or any Tender.
S. G. S. YOUNG,
Secretary.
Offices: The White Mansion,
91, Petty France, S.W. 1,
7th April, 1926. 2112

The Madras and Southern Mahratta RAILWAY COMPANY, Limited, 25, Buckingham Palace-road, Westminster, S.W. 1, invite TENDERS for :—
(i.) FILES.
(ii.) 42 TONS RED and WHITE LEAD.
(iii.) 563 TONS (approx.) TIE BARS, GIBS and COTTERS for 90 lb. B.H. RAILS.
(iv.) 522 TONS (approx.) BEARING PLATES.
(v.) 337 TONS (approx.) DOG SPIKES.
(vi.) 218 TONS (approx.) CHAIR SPIKES.
Tenders are due in on 27th April, 1926, by 2 p.m. Tender forms obtainable at above address. Fee One Guinea each, which is not returnable.
The Directors do not bind themselves to accept the lowest or any Tender. 2093

River Tees.—The Tees Conservancy COMMISSIONERS invite APPLICATIONS for the APPOINTMENT of ENGINEER, who will be required to devote the whole of his time and attention to the duties of the office; no private practice or the holding of any other appointment will be permitted.
Candidates must have had practical experience in carrying out the various works appertaining to Rivers and Estuaries, particularly the Construction and Maintenance of Breakwaters, Reclamation of Tidal Foreshore, and the latest types of Heavy River Moorings.
The successful candidate will be required to commence duties on the 1st October, 1926, and to join the Tees Conservancy Superannuation Fund.
Applications, stating professional qualifications, age, experience and salary required, accompanied by copies of three recent testimonials, addressed to the undersigned and endorsed "Application for Engineer," will be received on or before the 28th April, 1926.
JOHN H. AMOS,
General Manager.
Board Room, Middlesbrough,
7th April, 1926. 2113

PUBLIC NOTICES

Liverpool Corporation Water-Works.
VYRNWY SUPPLY.
THIRD INSTALMENT.
CONTRACT NO. 2.
PIPE LAYING.
The Water Committee of the Liverpool Corporation are prepared to receive TENDERS from competent persons willing to enter into a contract for the LAYING of STEEL PIPES of 42in. internal diameter and other ancillary WORKS, as follows :—
From Hirnant to Wern-Ddu, in the County of Montgomery, and from Lloran-Ganol to Bodlith, in the County of Denbigh, for a distance of about 4¼ miles.
The plans and sections may be inspected and copies of the specification and form of Tender obtained on and after Monday, the 5th instant, at the Water Engineer's Office, Alexandra Buildings, 35, Dale-street, Liverpool, upon payment of the sum of Five Guineas, which amount will be returned upon receipt of a bona fide Tender.
Tenders, endorsed "Tender for Pipe Laying," are to be sent through the post in a sealed envelope, addressed "Chairman of the Water Committee, Town Clerk's Office, Municipal Buildings, Liverpool," so as to be delivered not later than Twelve o'clock Noon on Monday, the 26th April, 1926.
The Water Committee do not bind themselves to accept the lowest or any other Tender.
WALTER MOON,
Town Clerk.
Municipal Buildings, Liverpool,
April, 1926. 2080

Metropolitan Borough of GREENWICH.
CONSTRUCTION OF JETTY.
The Council of the Metropolitan Borough of Greenwich is prepared to receive TENDERS for the CONSTRUCTION of a REINFORCED CONCRETE JETTY at its Tunnel-avenue Depot, East Greenwich.
Copies of the drawings and specification, together with the form of Tender, may be obtained upon application to the Borough Engineer and Surveyor, Town Hall, Greenwich, S.E. 10, between the hours of 10 and 4 p.m. (Saturdays, 10 and 12 Noon), and upon payment of a deposit of £5 5s., which will not be refunded except upon receipt of a bona fide Tender which is not subsequently withdrawn.
The specification does not provide for any particular system of reinforcement, but contractors must submit with their Tenders detail drawings and particulars of the system they propose to employ.
Contractors will be required to pay such rates of wages and observe such hours and conditions of labour as are recognised by Associations of Employers and Trade Unions, or settled by Arbitration Court legally established.
Sealed Tenders, endorsed "Tender for Jetty," must be delivered to the undersigned not later than Twelve o'clock Noon on Monday, the 10th May, 1926.
The Council does not bind itself to accept the lowest or any Tender.
FREDERICK J. SIMPSON,
Town Clerk.
Town Hall, Greenwich, S.E. 10,
29th March, 1926. 2054

SITUATIONS OPEN
COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED by Railway Wagon Building Firm, an ASSISTANT WORKS MANAGER. Applicant to have had experience in handling labour, works progress, steel wagons, and some knowledge of engineering. South Wales. State salary proposed.—Address, 2088, The Engineer Office. 2088 A

WANTED, INSPECTION SUPERINTENDENT for mechanical side of large firm of Commercial Motor Vehicle Manufacturers, capable of controlling all inspection work on component parts and the testing of units and finished chassis. Must be good organiser, with first-class experience.—Address, stating age and salary required, 2075, The Engineer Office. 2075 A

WANTED, MACHINE SHOP MANAGER, with first-class experience in production work, including Gear Cutting, Jigs and Tools, &c. State age, experience, and salary required.—Address, 2051, The Engineer Office. 2051 A

A COMMERCIAL ENGINEER is REQUIRED to Organise and Manage the Agency Department of a Westminster Firm holding valuable agencies for Cranes, Excavators, Crushers, &c. Terms would be arranged purely on a profit-sharing basis. First-class office accommodation and all facilities provided. Correspondence is invited in the first instance as to experience, connection, and capacity for big business, in strict confidence.—Address, 2083, The Engineer Office. 2083 A

CONSULTING ENGINEER and MANUFACTURER has an OPENING in his London Office for a PREMIUM PUPIL. Must have a good general education, some knowledge of drawing an advantage. Would be given a thorough training with a view to a permanent post when proficient. Interview by appointment.—Address, 1986, The Engineer Office. 1986 A

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CONTRACTORS' ENGINEER AGENTS REQUIRED; good salary to suitable men.
1. Capable of taking charge of public works generally.
2. Capable of taking charge of reinforced concrete construction. Preference in this case will be given to those speaking French and/or another foreign language.
Applications will be treated in confidence and none but first-class men having held responsible positions will be considered.—Address, giving full particulars of past experience, stating salary expected, &c., 2112, The Engineer Office. 2112 A

DIESEL ENGINE DESIGNER.—MANUFACTURING FIRM of ENGINEERS have an OPENING for a GENTLEMAN with good knowledge of the latest practice in Diesel Engine Design. Continental experience an advantage. Manufacturers have particularly in view engines of small size with mechanical injection. —Please address, with full particulars, 2076, The Engineer Office. 2076 A

ENGINEER REQUIRED, Experienced in the Preparation and following up of Tenders involving a thorough knowledge of HIGH-SPEED STEAM ENGINES.—Replies, giving full details of qualifications, experience, and salary required, to be addressed to W. H. ALLEN SONS and CO., Ltd., Bedford. 2078 A

ENGINEER WANTED, to Take Charge of London Shop well equipped for small repetition work and develop output. Contracts in hand cover six months' work. Must be able to influence at least £5000 to be invested in shares in limited company. Principals only need apply.—Write, Box 1967, Sells, Fleet-street, E.C. 4. 2108 A

LIMESTONE QUARRY MANAGER REQUIRED, to Take Entire Control of Large Quarries with Lime Kilns. Engineering knowledge essential. Good salary and prospects. Only experienced men need apply.—Address, 2079, The Engineer Office. 2079 A

SPRING SHOP MANAGER WANTED, Experienced in manufacture of Laminated and Coil Springs for Railway Work.—Apply, S. FOX and CO., Ltd., Stocksbridge Works, near Sheffield, stating experience and salary required. All applications to be addressed to the "Works Manager." 2115 A

TECHNICAL PUBLICITY, ADVERTISING AND CATALOGUE WORK.—WANTED, for Engineering Firm, first-class MAN with initiative and ideas. Take full charge.—Address, "PUBLICITY," Wm. Porteous and Co., Advertising Agents, Glasgow. P1759 A

WANTED, DRAUGHTSMAN, Accustomed to Internal Combustion Petrol 'Bus and Lorry Engines.—Address, stating full experience, salary required, 2072, The Engineer Office. 2072 A

WANTED, DRAUGHTSMAN, Accustomed to Light Railway Carriage and Wagon Work and all types of Contractors' Tipping and Bogie Wagons.—Address, stating full experience and salary required, 2073, The Engineer Office. 2073 A

WANTED, JUNIOR JIG and TOOL DRAUGHTSMAN, preferably one with experience in the Lay-out of Plant.—Applications, stating age, experience, and wages required, to KARRIER MOTORS, Limited, Huddersfield. 2077 A

CON. STEEL WORK DRAUGHTSMAN WANTED; one used to the requirements of the 1909 Building Act (Steel-frame Buildings). Good designer and detailer of shop drawings.—Address, stating age, experience, salary required, and when free for engagement, P1762, The Engineer Office. P1762 A

DESIGNER REQUIRED for Works in the South of England. Must be accustomed to designing complete machines of an intricate nature. Preference given to a man who has also had some experience in the lay-out of drawings for production work.—Address, stating age, experience, and salary required, 2117, The Engineer Office. 2117 A

SITUATIONS OPEN (continued)

DRAUGHTSMAN and ESTIMATOR REQUIRED, with thorough knowledge of Iron and Steel-framed and Timber-framed Buildings. Able to prepare estimates and working details for orders. Previous experience with other firms in this line essential. —Apply by letter only, with copies of testimonials and full details of such previous experience, and salary required, to DAVID ROWELL and CO., Ltd., 14, Howick-place, Westminster. P1770 A

DRAUGHTSMAN DESIGNER REQUIRED, London for Calculations and Design of Steelwork for Bridges, Factories, Jetties, &c. State experience, age and salary required.—Address, 2122, The Engineer Office. 2122 A

DRAUGHTSMAN REQUIRED, Experienced in the design of Road Rollers, Steam and Internal Combustion. State age, experience, and salary required.—Address, P1785, The Engineer Office. P1785 A

DRAUGHTSMAN WANTED, West London District, with experience in Piping Lay-outs and Steel Tank Construction. State age, salary required and experience.—Address, P1781, The Engineer Office. P1781 A

DRAUGHTSMAN WANTED for Railway Engineer's Office, experienced in Building Construction, Steel Work and Surveying. State age and salary required.—Address, 2087, The Engineer Office. 2087 A

EXPERIENCED DRAUGHTSMAN, Accustomed to Steam and Electric Road Vehicles. State age, experience, and salary required.—Address, 2074, The Engineer Office. 2074 A

FIRST-CLASS MECHANICAL DRAUGHTSMAN WANTED for Large Factory, London, E., with at least 5 years' drawing-office experience, accustomed to the design and lay-out of Buildings and Plant.—Apply by letter, stating age, qualifications, experience, and salary, to M. D., c/o Abbott's, Eastcheap, London, E.C. 3. P1760 A

HEAD DRAUGHTSMAN REQUIRED in Works of about 800 hands. Only those need apply who have had extensive experience in the designing of intricate mechanism and the organisation of a drawing-office engaged on work produced by up-to-date methods.—Address, stating age, full experience, and salary required, 2116, The Engineer Office. 2116 A

HEATING AND VENTILATION.—London FIRM REQUIRE the SERVICES of a capable DRAUGHTSMAN; must be experienced in Designing Schemes and Preparing Estimates for every type of Installation. A commercial knowledge an advantage. State fully qualifications, age, salary, &c.—Address, P1763, The Engineer Office. P1763 A

LADY TRACER REQUIRED, West London district, fully proficient. State age, salary required and experience.—Address, P1782, The Engineer Office. P1782 A

LEADING DRAUGHTSMAN WANTED IMMEDIATELY, to Take Charge of Section engaged upon design of Tramway Rolling Stock, Trucks and Brake Gear. No application entertained from those not having previous experience on design and construction of above. Good salary and bonus on profits will be paid to right man. Permanent and progressive position.—Apply, in strict confidence, giving full particulars of experience, age, and salary expected, to ELECTRO-MECHANICAL BRAKE CO., Ltd., Eagle Works, West Bromwich. 2114 A

MECHANICS, FITTERS and ENGINEERS, Desiring more congenial and lucrative employment, should write for particulars of my intensive course in draughtsmanship. There is an increasing demand for qualified draughtsmen and you can learn this interesting profession while you are earning. Postal or private tuition by arrangement.—PERCY PITMAN, M.I. Mech. E., 25 Victoria-street, Westminster, S.W.1. 1907 A

PATTERNMAKERS.—Permanency for Capable Men. District rate.—Apply, P. J. SMITH, 2a, Wynyatt-street, Goswell-road, E.C. 1. 1927 A

SITUATIONS WANTED

A SUCCESSFUL Qualified MECHANICAL ENGINEER (26), with 10 years' technical and practical experience with internal combustion engines of all kinds, from crude oil to petrol and gas, a wide range of steam engines and boilers, woodworking machinery, pumping plant, motor vehicles, and some electrical work, SEEKS a POSITION as Manager of Works of moderate size (or a similar function), as his present position lacks possibilities of advancement.—Address, P1765, The Engineer Office. P1765 B

ADVERTISER, Lately Managing Director of Thomas Shanks and Co., Ltd., Johnstone, DESIRES EMPLOYMENT in any capacity.—W. G. SHANKS, Melfort, Millikenpark. P1767 B

ENGINEER, Extensive Commercial, Financial and works experience, high-class light and heavy repetition work, present firm 14 years, £2000-a-year man, DESIRES CHANGE.—Address, P1772, The Engineer Office. P1772 B

ENGINEER (28), B.Sc. (Mech. Eng.), Disengaged, varied works and D.O. experience on automatic special purpose machinery and mechanisms, presses, press tools and general engineering, accustomed to controlling men and organising, SEEKS POSITION holding prospects.—Address, P1777, The Engineer Office. P1777 B

ENGINEER (36), Technical and Practical, DESIRES POSITION; 13 years' experience design, erection, maintenance chemical process plant (alkali, &c.), including power plant, heating, cooling, evaporating, solvent gas recovery, distillation, &c.—Address, P1764, The Engineer Office. P1764 B

ENGINEER (39), with 18 Years' Works and Office experience in the production of accurate steel repetition work, SEEKS responsible POSITION.—BAILEY, 2, Westminster-road, Coventry. P1772 B

EXTRA-FIRST CLASS (B.O.T.) ENGINEER, Age 27, OPEN for POSITION at home or abroad, with prospects depending on work and ability.—Address, P1751, The Engineer Office. P1751 B

KEEN, Live Man, GENERAL MANAGER, DESIRES similar POST with progressive engineering firm, accustomed to control large factory, expert, economical administrator and organiser; has personal detail modern knowledge of all departments, from design to intensive sales. Excellent testimonials, proving successful results.—Address, P1771, The Engineer Office. P1771 B

MAINTENANCE ENGINEER and FOREMAN ERECTOR REQUIRES POST; 18 years' mech. and electrical experience, Diesel engines, pumps, steam and general millwrighting, tech. education and draughtsman.—Address, P1761, The Engineer Office. P1761 B

REINFORCED CONCRETE SPECIALIST DESIRES ENGAGEMENT. Considerable experience in design and construction of reinforced concrete work for buildings, &c.; accustomed to full responsibility; first-class testimonials.—Address in first instance, P1778, The Engineer Office. P1778 B

CHIEF DRAUGHTSMAN, Constructive Organiser and competent designer, with sound technical training, varied experience, good practice, and ability to control staff, SEEKS POST with Mechanical Engineers.—Address, P1775, The Engineer Office. P1775 B

DRAUGHTSMAN and ENGINEER, London, 12 years shops, 17 years office; all-round experience; moderate salary.—Address, P1783, The Engineer Office. P1783 B

LEARN SURVEYING and LEVELLING.—Thorough practical instruction by expert.—E. MOUL (late L.S.W. and S.P.D. Rly.), Hollybank, Woking. P1749 E

PARTNERSHIPS

IF YOU ARE SEEKING
A PARTNER or PARTNERSHIP
or wish to buy or sell a
BUSINESS or WORKS
Write:
WHEATLEY KIRK, PRICE & CO.,
46, Watling Street,
London, E.C. 4.
Established over 70 years.

CAPITAL PROCURED for Private and Public Companies by retired bank official from clients prepared to invest £2000 to £5000 as non-active or active directors. Proofs available of investments amounting to over £300,000 made by clients. Fee on completion. —Write, Box 19, Pool's, 180, Fleet-street, E.C. 2067 C

£5000 UNIQUE OPPORTUNITY OCCURS for Merchants of Engineering Products or Gentleman with same.—Address, P1768, The Engineer Office. P1768 C

MANUFACTURING BUSINESS, with Splendid Prospects, can give SUBSTANTIAL SHARE and GOOD POSITION to ENGINEER investing £500 secured on stock.—BRUFORD and ANDERSON, Consulting Engineers, 80, Coleman-street, London, E.C. P1784 C

EDUCATIONAL

COACHING in CIVIL ENGINEERING SUBJECTS. —To G. W. M. BOYCOTT, Assoc. M. Inst. C.E., Chandos House, Palmer-street Westminster, S.W. 1. 1881 E

CORRESPONDENCE COURSES for Inst. C.E., Inst. Mech. E., London Univ. (Matric., Inter B.Sc.), and ALL ENGINEERING EXAMINATIONS, personally conducted by Mr. TREVOR W. PHILLIPS, B.Sc. (Honours), Eng., London, Assoc. M. Inst. C.E., Chartered Civil Engineer, M.E.S.I., F.R.S.A., &c. Also Day Tuition in Office. Excellent results at all Exams., comprising hundreds of successes. Courses may commence at any time.—Apply to Mr. TREVOR W. PHILLIPS, B.Sc. (Hons.), A.M.I.C.E., &c., 8/11, TRAFFORD CHAMBERS, 55, SOUTH JOHN-STREET, LIVERPOOL. Telephone No. 1113 Bank. Ex. E

PITMAN'S POSTAL COURSE IN ENGINEERING DRAWING.—My old-established and intensive course in Mechanical Draughting and Machine Design is of the greatest value to all those preparing for examinations, or who are employed in the daytime and are anxious to obtain a more interesting and profitable occupation. Students prepared for all Engineering examinations. The course may be started at any time.
Send for particulars and enrolment form.
PITMAN'S, 29, Victoria-street, London, S.W. 1.

For continuation of Small Advertisements see page 3.

WANTED.

A well-known Firm of Engineers on the lists of the Admiralty, War Office, India Office, Crown Agents for the Colonies, Indian State Railways, etc.—with Modern Works well equipped with up-to-date machinery—WISH to UNDERTAKE the MANUFACTURE of one or two PROPRIETARY ARTICLES, and, if required, are PREPARED to HANDLE the SELLING of SAME. Their Sales Department is well organised—Six Branches in Great Britain—and they have a Good Connection with Consulting Engineers, Architects, Steel Works, Shipbuilders, Railways, Export Merchants, etc., and are PREPARED to TAKE UP one or two SELLING AGENCIES for firms of approved standing whose manufactures DO NOT COMPETE WITH THE GOODS DETAILED BELOW:—

ELECTRIC:

CRANES OF ALL TYPES - -
PASSENGER AND GOODS LIFTS,
CAPSTANS, WINCHES and BLOCKS.

HYDRAULIC:

LIFTING, SHIP, BOILER FLUE AND PULLING JACKS. PRESSURE PUMPS AND BOILER PROVERS. RAIL, SHAFT AND GIRDER BENDERS AND STRAIGHTENERS. WHEEL PRESSES.

WESTON'S SPUR AND WORM GEAR PULLEY BLOCKS, WIRE AND HEMP ROPE BLOCKS, SELF-LUBRICATING CARGO BLOCKS, SCREW LIFTING AND TRAVERSING JACKS, SCREW AND HYDRAULIC BEARS.

Box No. 1805, c/o "The Engineer."

A Seven-Day Journal

The Nottingham Trent Bridge.

ON Saturday last, the 3rd inst., the bridge over the Trent at Nottingham, which has recently been widened, was brought into full service. The main alteration has consisted in increasing the width of the bridge from 40ft. to 80ft. by the addition of new steel arches. Such an alteration was necessitated by the greatly increased traffic on the wide approach roads. The bridge before its alteration was a fine example of the cast iron arch type. It was erected in 1871 to the designs of Mr. M. O. Tarbottom, M. Inst. C.E., by Andrew Handyside and Co., of Derby. There were three 100ft. arches, each with a rise of 11ft. at the crown, and the supports were carried on foundations made in the solid sandstone. In order to widen the bridge three new arch ribs of steel have been added, and the older portion of the cast iron arches has been strengthened by embedding it in reinforced concrete. The new bridge has a carriageway width of 56ft. between the kerbs, with a pathway 12ft. wide on each side. The improvement has been made with the aid of the Ministry of Transport, and the new work has been carried out to the designs of Messrs. Mott, Hay, and Anderson, consulting engineers, Westminster, and the city engineer, Mr. T. Wallis Gordon. The contractors were the Cleveland Bridge and Engineering Company, Ltd., of Darlington. It is expected that the total cost of the widening scheme will be about £120,000.

A New Hamburg-American Liner.

THE new liner Hamburg, which leaves Cuxhaven to-day—Friday—calling at Southampton to-morrow, on her maiden voyage to New York, is the latest ship to be added to the fleet of the Hamburg-American Line. Like her sister ship, the Albert Ballin, described in our issues of September 14th and 21st, 1923, she is a twin-screw geared turbine vessel. She differs a little in outside appearance from her sister, in that she has two masts instead of four, and her two funnels are slightly longer. The principal dimensions of the Hamburg are as follows:—Length between perpendiculars, 183 m.; breadth over side bulges, 24 m.; depth, 17 m. She is provided with accommodation for 222 first-class passengers, 476 second-class, and 456 third-class, and in addition her cargo holds are designed for 12,500 cubic metres capacity, including 450 cubic metres of refrigerated space. The propelling machinery developing 13,000 total shaft horse-power is particularly interesting, as it has been arranged for maximum fuel economy. The main turbines are supplied with steam from four double and four single-ended oil-fired boilers, with a total evaporating surface of about 3000 square metres. Superheaters with 1380 square metres of surface giving the steam a total temperature of 350 deg. Cent. are fitted. Air preheaters, of the Howden type, are employed, and also exhaust steam and flue gas feed heaters, which raise the boiler feed to a final temperature of about 160 deg. Cent. Only a part of the deck and engine-room, auxiliary machinery is steam driven, so that at sea the exhaust steam can usefully be employed for feed heating, while in port a small auxiliary boiler will provide all the steam necessary. The remainder of the auxiliaries are electrically driven, current being provided by four Diesel generators, with a total output of about 600 kilowatts. The four oil engines are arranged aft of the main engine-room, between the propeller shafts, and they are secured to strong foundations built into the double bottom. It is stated that by using combined steam and electric auxiliaries a saving of a quarter of a million marks per year in oil fuel will be made.

The Lochaber Hydro-electric Scheme.

SPEAKING at a meeting last week of the British Aluminium Company, Ltd., the chairman, Lieut.-Colonel S. H. Pollen, gave a few brief particulars of the progress being made with the Lochaber hydro-electric scheme. That scheme, tapping a drainage area of over 300 square miles in the Western Highlands of Scotland, will, it is anticipated, yield 70,000 to 75,000 electrical horse-power continuously, with more in favourable periods. It is being executed by the Lochaber Water Power Company, an offshoot of the Aluminium Company, and was dealt with in some detail in our issue of March 4th, 1921, when it was in the parliamentary Bill stage. According to Colonel Pollen's statement, substantial progress has been made with the civil engineering portions of the work. The pier on Loch Linhe, an approach viaduct and embankment, and a bridge over the river Nevis, all of which are required for the service of the aluminium factory at Fort William, are in an advanced stage of construction. The principal work is, however, the main tunnel, 16ft. in diameter and 15 miles long—believed to be the largest tunnel of its type in the world—which will run from Loch Treig to Fort William. This tunnel is to be driven from more than twenty faces, which will be approached by adits or shafts having a total length of over 1½ miles. A feature of the operations now in progress is the very large amount of preliminary and temporary works that have had to be carried out. A railway for access purposes, which, with branches and sidings, extends to about 27 miles, has been laid down, and has involved the construction of 100 bridges and 368 culverts. To provide power for the whole of the constructional work, a temporary hydro-electric station, served by a tunnel over a quarter of a mile long and containing power plant of 4500 horse-power, has been erected. By means of 24 miles of high-tension transmission line, this station will supply the energy for driving the rock-drilling machinery, &c. In addition, repair workshops have had to be established for the maintenance of the constructional machinery. All these temporary works are now practically completed, and operations on the main tunnel have been begun.

New Oil Tank Vessels.

A NOTABLE order for four new motor oil tankers has been placed with Harland and Wolff, Ltd., Belfast, by the Anglo-Saxon Petroleum Company, Ltd., of London. The vessels include one of 1050 tons, two of 2300 tons, and one of 3600 tons, and all will be propelled by Harland-B. and W. type marine oil engines, which are to be built at Glasgow. At Dundee the Caledon Shipbuilding and Engineering Company, Ltd., is to construct an oil-carrying vessel for the same owners in which Werkspoor engines, built at Amsterdam, will be fitted. This vessel is one of six tankers for which twelve sets of double-acting, four-stroke Werkspoor engines, referred to in our issue of February 12th, are being constructed at Amsterdam and on the Tyne at the works of the North-Eastern Marine Engineering Company, Ltd., and Hawthorn, Leslie and Co., Ltd. Other oil-carrying ships which have recently been ordered by the Anglo-Saxon Company, Ltd. include four of 2300 tons, which will be built by Swan, Hunter and Wigham Richardson, Ltd., Wallsend-on-Tyne; Werf Gusto, Schiedam, Holland; the Rotterdam Dry Dock Company, Ltd., Holland; and Cantiere Navale Triestino, Trieste. These vessels will be propelled by steam machinery. An oil tanker of 10,000 tons was recently ordered by British Tankers, Ltd., London, from Sir James Laing and Sons, Ltd., Sunderland. It will be propelled by Doxford opposed-piston engines.

The Government Airship.

FROM a reply given last week in Parliament by the Secretary for Air, we gather that work is now proceeding on the construction of the 5,000,000 cubic foot rigid airship R 101, which the Government decided two years or so ago that the Air Ministry should build at the Cardington Works, simultaneously with the construction of the R 100 by the Airship Guarantee Company. Similar announcements, indicating the beginning of constructional work on this airship, have previously been made, but on this occasion the information made available is a little more definite. Sir Samuel Hoare stated that certain preliminary constructional work on the power cars and internal structure was now proceeding. The girder work for the hull has apparently been let on contract. Delivery of the girders is expected in the summer. To this official information may be added the news that a Croydon firm, Metal Propellers, Ltd., has recently completed for the R 101 a two-bladed stainless steel airscrew, over 16ft. in diameter. This screw, one of a batch, is, we learn, fitted with hub gearing, whereby the angle of incidence of the blades may be varied. It hardly seems probable that the airship, as at one time was anticipated, will be ready for trial by the beginning of 1927, but from the outset the plan has been followed of proceeding with her design and construction with systematic leisure. It is to be hoped that the outcome will justify the expenditure of time and money in a better degree than that other example of leisurely Governmental aircraft construction, the Brennan helicopter. That machine, it was officially stated last week, has cost the country £55,000. Of that sum, £40,000 represents the cost of labour, material and establishment charges at the Royal Aircraft Establishment, and £7000 the salaries of the design staff working under Mr. Brennan, the inventor receiving the balance. It has been claimed in Parliament that the experiments conducted with the machine have justified the expenditure, but farther expense on them is not to be incurred. The machine, as a result of a mishap during a test, is now in a damaged condition, and has been offered by the Air Ministry to its inventor.

The National Physical Laboratory.

IN the annual report on the work of the National Physical Laboratory, published by H.M. Stationery Office just before the holidays, an interesting statement will be found summarising the number of tests carried out in the different departments. It may not be quite correct to take the figures given in this statement as a true reflection of the directions in which the Laboratory's activities are mostly employed, for numerous small routine tests do not necessarily absorb as much attention as half a dozen large fundamental investigations. Nevertheless, the figures are worthy of being recorded. In the Physics Department the testing of thermometers during 1925 provided by far the largest amount of work, as judged on a numerical basis, the number of tests conducted under this heading having been 615,044, of which 609,033 were on thermometers of the clinical variety. The testing of telescopes came second, with 1767 tests. No other category of tests reached 400 in number. In the Electricity Department first place was occupied by photometric tests on incandescent lamps, of which 544 were conducted during the year. Second and third places were taken by signal glasses and electricity supply meters, which were tested to the number of 328 and 310 respectively. Fourth place was occupied by photometric tests on ships' lamps, of which 286 were undertaken. In the Metrology Department, 11,517 taximeters were tested and 5667 taximeter gear-boxes. End, cylindrical, screw and other forms of gauge were tested to the number of 4690. Fourth place was held by 4124 tests of the capacity of glass and other vessels, and fifth by 1959 tests of weights. In the Engineering Department tests on the strength of materials were an easy first with 796 as the number conducted. In the second place were 79 tests on road materials, and in the third 44 tests on standard reference jets.

The One-Man Tank.

A FAIRLY full description of the Martel one-man tank, which underwent its first trials last August, was published by the military correspondent of the *Daily Telegraph* last week. The vehicle described, an improvement on the original design, has been constructed on behalf of the War Office by Morris Commercial Cars, of Birmingham, and is driven by a standard Morris engine. The tank is built of ordinary car components with the object of creating a demand for it—minus its military equipment—as an agricultural tractor and so facilitating and cheapening its military production. The chassis is standardised and on to it any type of body may be bolted. For military use either a one-man or a two-man armoured body may be fitted or, alternatively, it may be equipped with a car body for reconnaissance work or with a fitting for an anti-aircraft gun. The chassis is carried on two endless tracks, each surrounding two main wheels. Behind it is supported on two disc wheels provided for steering purposes and to prevent the vehicle from toppling backwards when going up a steep incline. A feature of the design is the fact that the tracks are made of rubber. It is claimed that they can withstand a rain of machine gun bullets without their utility being impaired, for if they are pierced the holes close up immediately after the bullet has passed through them. The armoured body carries a turret, above the upper edge of which the driver's head normally projects. When under fire the driver, by a touch on a lever, causes his seat to drop 6in. In this position he secures vision through a horizontal slit in the turret at the level of his eyes. A vertical slit in the front plate of the turret provides an opening for a light machine gun.

The Flettner Rotorship.

THE original rotorship, the Buckau, propelled on Herr Anton Flettner's system, did not give a very satisfactory account of herself and was sold by the Flettner Company, at, it is reported, a big loss. Her new owners appear, however, to have faith in her, for, re-christened the Baden-Baden, she is now on her way from Kiel to America with a cargo of lumber. The voyage, it is expected, will take from fifteen to twenty days to complete. On the same day as the Baden-Baden left Kiel Herr Flettner also set out for America for the purpose of delivering a series of lectures. He travelled, we note, not by the rotorship, but by a Hamburg-American liner. Lecturing, it would seem, is not to be the only outcome of the invention. It is reported that the Flettner Company still believes in the rotor principle of ship propulsion, and that, backed by the German Admiralty, steps are now being taken for the construction of a 3000-ton rotorship for the German shipping firm of Sloman and Company. The vessel will, it is expected, be ready for her first trials by about the middle of July.

The French Institution of Naval Architects.

IT is announced that M. Emmanuel Rousseau has been nominated as the new president of l'Association Technique Maritime et Aeronautique, in succession to M. Doyère, who has been chairman for several years. M. Doyère has done much for the Association during his term of office, and it will be remembered that he was the leader of the French delegation to the Joint Meeting of the Institution of Naval Architects, the Institution of Engineers and Shipbuilders in Scotland, and the North-East Coast Institution of Engineers and Shipbuilders, held in London, Glasgow and Newcastle in 1924. Unlike our own Institution of Naval Architects, the French Association is closely allied to the State, and it receives grants from the Departments of the Navy, the Mercantile Marine, and Aeronautics. In virtue of a decree of February last it was awarded the title of an establishment of public utility, a step which may be regarded as a recognition of the important position the Association holds in official and industrial circles in France. The general secretary of the Association is M. Bourges, who is also the general secretary of the Syndical Chamber of French Shipbuilders.

Links in the History of the Steam Engine.

A DOCUMENT of the highest importance in the history of the steam engine—certainly the most important contribution to our knowledge of the subject during the last half-century—has recently come to light. We take, as has been our wont in like cases in the past,* an early opportunity of bringing it before our readers.

The document in question is a line engraving from a copper plate, 8⅞in. by 8¼in., entitled "The ENGINE for Raising Water (with a power made) by Fire." The drawing itself, which is reproduced herewith somewhat reduced, occupies about two-thirds of the paper, the remainder of which is blank, save for the words "To the Hon^ble Geo Clark, Esqr.," and "R from Mr. Beighton—Sept. 16th, 1718," which has been written on by hand. The engraving was first noticed by Mr. L. de M. Johnson, Printer to the Delegates of the Oxford University Press, when browsing over some old portfolios in the Library of Worcester College, Oxford. Although he did not realise fully the implication of his discovery, he communicated it to the Newcomen Society for the Study of the History of Engineering and Technology, which has had it reproduced in collotype in the latest volume of its "Transactions." We are indebted to the Council for permission to reproduce the plate.

The most important point about the engraving is that it is dated 1717, *i.e.*, two years earlier than the date of the earliest document hitherto known, viz., the print of "The Steam Engine near Dudley Castle, invented by Capt. Savery and Mr. Newcomen. Erected by ye latter 1712." This print published in 1719 first came into public notice at the Loan Collection of Scientific Apparatus at South Kensington in 1876, when its importance was emphasised in these columns.†

Close examination of this print goes to show that while the engine was substantially in the condition when erected, there had been minor changes in some of the parts during the intervening seven years between its erection and its delineation. The artist's ignorance of the functions of what he saw has also led him into some confusion.‡

In the recently discovered print now before us we feel on safer ground altogether, principally because of the subscription "H. Beighton delin. 1717." Henry Beighton was known in his day for his scientific attainments, which procured for him the Fellowship of the Royal Society. He practised land surveying, and was the author of a valuable map of Warwickshire. He resided at Griff in that county.

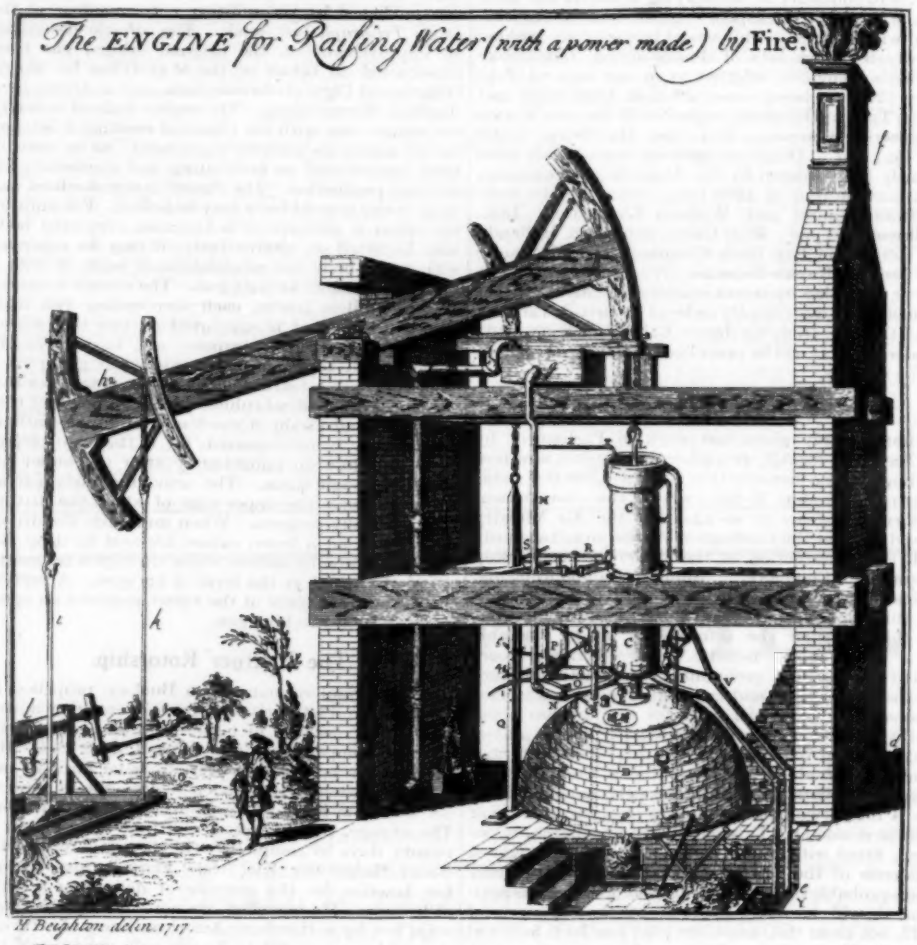
Now we know that about 1715 or 1716 Savery's patent, under which Newcomen's invention was worked, became vested in a company known as the "Proprietors of the Invention for Raising Water by Fire," which inserted the following advertisement in the *London Gazette* for August 11th–14th, 1716:—

"Whereas the invention of raising water by the impellant force of fire, authorized by Parliament, is lately brought to the greatest perfection, and all sorts of mines etc, may be thereby drained, and water raised to any height with more ease and less charge than by the other methods hitherto used, as is sufficiently demonstrated by diverse engines of this invention now at work in the several counties of Stafford, Warwick, Cornwall and Flint.

"These are therefore to give notice that if any person shall be desirous to treat with the Proprietors for such engines, attendance will be given for that purpose every Wednesday, at Sword Blade Coffee House, in Birchin-lane, London, from 3 to 5 of the clock; and if any letters be directed thither to be left for Mr. Eliot the parties shall receive all fitting satisfaction and dispatch."

We cannot here go into details, so far as they are known, of what led up to the formation of the company alluded to above, but particulars will be found in the society's "Transactions" to which we have referred. Suffice it to say, that all engines erected prior to the company coming on the scene, *i.e.*, those alluded to in the advertisement, were erected by Newcomen in person, and they were, in fact, very few in number. We can hardly doubt, therefore, if we look closely at the facts, that the engine in Warwickshire mentioned in the advertisement and the engine shown in our illustration are one and the same. That this extraordinary invention should attract the attention of a keen mind like that of Beighton is just what would be expected, especially when it appears that the colliery where the engine was erected was in his immediate neighbourhood. That he should have "taken a draught" of it is a matter for satisfaction, for here we can say that we have at last the engine as it came from the brain of Thomas Newcomen. The year or two that had elapsed between its erection and the date of the print would not allow time for alteration. How great an interest Beighton took in the engine is evinced by the fact that he erected at least one himself—that at Washington, Co. Durham, in 1718. He is credited, moreover, with an improvement in the valve gear.

The print before us has upon it a number of reference letters, but unfortunately the legend belonging to them has not been preserved. We should like to have had it, if only for the quaint phraseology in which it is sure to have been worded, but it is permissible to give it in modern dress:—



AN EARLY NEWCOMEN PUMPING ENGINE

A. Fireplace.
B. Boiler, in brick setting.
C C. Cylinder and piston.
D. Steam pipe.
E. Steam valve or regulator.
F. Deadweight safety valve.
G. Gauge cocks for high and low water.
H. Buoy pipe; in this was a buoy which, when the steam pressure increased above the atmospheric, forced up the lever R and interceptor 7, releasing the notch of the injection cock. The tail of this cock is restored by a pin in the plug rod.
I. Stand pipe for feed water and for indicator attached to K
K. Ball float in boiler.
L. Piston-rod.
M. Pipe from cistern supplying injection water.
N. Injection cock.
O. Spanner of injection cock; one end, 3, has a counterweight, the other 1 is struck by a pin in the plug rod.
P. Standards supporting the Y to work the steam valve 4 and 5 are tappets struck by pins in the plug rod; 6 is a strap to prevent the Y from falling too far either way.
Q. Plug rod.
R. Hinged lever to which interceptor 7 is attached.
S. Counterweight to R.
T. Eduction pipe for condensing water.
V. Emergency overflow from top of cylinder and from snifting valve.
W. Normal overflow from top of piston led to stand pipe 1 to feed boiler.
X. Snifting valve.
Y. Hot well.
Z. Water supply pipe to top of piston.
a a a a. Four beams supporting the engine.
b c d e. Ground floor of the engine house.
f. Chimney.
g. Cold water cistern to supply injection.
h h. Engine beam.
i. Pump rod.
k. Rod of force pump supplying cistern *g*.
l. Windlass for raising and lowering men and materials in the pit.
m. Supply pipe from pump *k* to cistern *g*.
o o o o. Outline of boiler.

We have here the parts that are more or less familiar to us. There is the circular domed boiler, with high and low water cocks; a safety pipe whose height shows that the pressure could not have exceeded about 1 lb. above atmospheric; the horizontal sliding valve, giving admission to the cylinder where the steam is condensed by internal injection; atmospheric pressure forces down the piston, air being excluded by a layer of water on the top. There is the great beam or pump handle that transmits the power to the pump rods; the weight of the latter overbalances the weight of the piston and rod to begin a fresh stroke, when steam is again admitted to the cylinder. There is the snifting or blow-through valve to eject from the cylinder air that has been entrained with the steam, &c., and that would otherwise cause "wind logging" and eventual stoppage. Then there is the valve gear. We see the plug rod that hangs from the great beam, and by pins strikes tappets on the arbour of the Y or tumbling bob that jerks the steam valve open or shut. The injection valve is tripped by another pin, but this part is not as clear as we could wish.

Here we have a grand combination of inventions in a complete machine, which we can date back prior to 1717. Making every allowance for the detractor who can contend that all that it was necessary to know about steam, and indeed about such organs as a cylinder and piston, was already known, we stand amazed at the conception of the design in the then state of the mechanic arts, when, for example, a boiler could only be made to sustain a steam pressure slightly in excess of that of the atmosphere; the fertility of resource in overcoming difficulties that could not have been foreseen and, above all, at the contrivances to secure repetition of the cycle.

* *cf.* Vol. C., page 129.
† Vol. XLI., page 389; *cf.* also XLVIII., page 400.
‡ But *cf.* letter in our columns, Vol. LXXXIII., page 61

Indian Irrigation: 1921-1924.

No. II.*

IMPORTANT WORKS UNDER CONSTRUCTION.

IN the Bombay Presidency, Sind, the Lloyd (Sukkur) Barrage and canals project was sanctioned in 1923, and in 1923–1924 the expenditure on these works amounted to nearly 23½ lakhs—about £157,000. The rupee is taken as equivalent to 16d. It may be added that up to April, 1925, an expenditure of a million sterling had been incurred, and it is expected that another two millions will have been spent by April, 1926. As stated in the Report, "The scheme is the greatest irrigation work ever undertaken, and, when completed, it is expected to inaugurate an era of unprecedented prosperity for Sind." The supply of water for the inundation canals of Sind depends on the rise and fall of the water level of the Indus (see Report for 1918–1921). When the Indus falls in the cold weather only a few of the canals obtain any supply and much water runs waste to the sea. The object of the barrage is to afford the irrigated area an assured supply throughout the year. The dam is, as our readers are aware, being built below Sukkur across the shallow terminating the diverging channel scoured by the current downstream of a deep and narrow gorge, and from that point four canals on the left bank and three on the right bank will run southwards, serving the area now irrigated and an enormous area at present waste. There will be sixty-six spans, each with a shutter 60ft. long by 18½ft. high, the whole length between the regulators

* No. I. appeared April 2nd.

on both sides being 4725ft. On the left bank, besides the two small canals, two great canals, the Rohri Canal and the Eastern Nara Feeder, will carry respectively 10,992 and 12,200 cusecs. The right bank canals will carry 19,446 cusecs during the monsoon and 6281 cusecs for the rest of the year. The estimated cost is 1835 lakhs, or over £12,000,000, of which the barrage accounts for 569 and the canals for 1266 lakhs. A gross area of 7½ millions of acres, 6½ millions cultivable, is commanded, and an area of 5½ millions will, it is expected, be cultivated annually.

In the Punjab a sum of 430 lakhs, or £2,867,000, was spent on the works of the Sutlej Valley project, sanctioned in 1921–1922. A feature of this scheme is the introduction of machinery on a large scale, including mechanical excavators, and the use of electric power generated in large power stations. The object of the project, which is a direct outcome of the triple canals project, is threefold. First, by means of weirs and head regulators, to afford the existing canals a controlled supply from the beginning of April to the middle of October; secondly, to extend these areas so as to include all the low-lying area in the river valley; thirdly, perennial irrigation will be given to large tracts in the uplands on both banks, areas at present unirrigated and waste. During the cold weather only 7000 cusecs will be required, but a maximum of 48,500 cusecs will be drawn off during the hot weather.

In the Deccan and Gujerat division of the Bombay Presidency the Pravara River works were carried to a stage pointing to completion in 1925–1926. The Bhandadara dam on this river was brought nearly to its full height of 270ft. Water was being made available for irrigation in increasing quantities. There is a possibility of developing 5000 electric horse-power. Nearly 135 lakhs, or £900,000, had been spent on the Pravara works by the end of the triennium. In the same province the Nira right bank canal works were in progress, and the dam at Bhatgar in connection with the Nira right bank canal is expected to be completed to its full height of 190ft. by the end of 1926. It is anticipated that the new storage will provide sufficient head for 3000 electric horse-power. Over 310 lakhs, or £2,067,000, had been expended by the end of 1923–1924.

In the United Provinces good progress was made on the Sardar Kichha feeder and the Sarda Oudh canals, the expenditure to the end of 1923–1924 being nearly 228 lakhs, or £1,520,000. To overcome pumping difficulties it has been decided to install an electrical power plant. The Deoha Barrage, eleven spans of 40ft. each with gates 12ft. high, was nearly completed.

SMALLER WORKS UNDER CONSTRUCTION.

In Madras Presidency some works of restoration and improvement were in progress. In the Godavari delta these included improvements to the Yenamadurru drain, estimate 9·74 lakhs. In the Kistna delta, replacing 3ft. shutters on the Kistna anicut by 6ft. shutters, estimate 3·9 lakhs; and the diversion of the Nallamada drain, estimate 7·35 lakhs; in the Cauvery delta, reconstructing the Thoppadanaveli dam, 1·14 lakhs; and improvements to the lower reaches of the Cauvery, 2·63 lakhs.

In Sind the works in progress included:—Improvements to Pinyari canal, the construction of a head regulator over the Baghar Canal, Garkino Canal project, a new head regulator over the Fuleli Canal, the raising of its banks, and the remodelling of two branches.

In Burma a considerable amount of river training work was in hand. The remodelling of the Pvaungbya branch of the Kinda canal project was begun in 1923–1924. The area to be added to the irrigated lands is about 10,000 acres, and the estimated cost 6·88 lakhs.

In the Central Provinces some progress was made in the construction of the Kharung Canal. Work is in progress in the construction of the Maniari reservoir in Bilaspur, which is intended to irrigate 80,000 acres of rice. Nine small works in connection with tanks were in hand.

In the North-West Frontier Province a bund is being built at an estimated cost of 14 lakhs, or £93,000, to protect the city of Dera Ismail Khan "from erosion by the Indus."

PROJECTS UNDER CONSIDERATION.

In February, 1924, negotiations were concluded with the Mysore State and the respective rights of Madras and Mysore in the waters of the Cauvery were defined. The revised estimate of the Cauvery (Madras) project is 6·12 crores, or about 4·08 million sterling. The project is intended to improve the present fluctuating supplies of water for the Cauvery delta irrigation and bring in a new area of 301,000 acres, which will, it is estimated, add 150,000 tons of rice to the food supply of the country. It is expected to yield a net revenue of 47 lakhs. The project has been sanctioned since the close of the triennium.

The Vengalapuram project in the Nellore district was under examination. It is expected to irrigate some 50,000 acres and to cost about 40 lakhs.

Pending negotiations with the Hyderabad Darbar investigations relating to a storage project on the Kistna River were discontinued. This project is for a reservoir at Sangameswaram to store 125,000 million cubic feet at a cost of 25·33 crores, or £16,887,000, for the irrigation of 1¾ million acres.

A modification of the Jungabhadra reservoir project is being examined, the proposal being to construct an anicut for the irrigation of about 80,000 acres. For the Coimbatore district the Lower Bhavani project for a storage reservoir on the Bhavani River has been recast. It provides for the irrigation of 110,000 acres at a cost of 2¼ crores. A project for the irrigation of a fertile area in the Godavery delta, at a cost of 18½ lakhs, has been prepared.

In the Bombay Presidency the most important project under consideration is the Nira Valley development scheme, involving a dam at Virwadi, with a reservoir storing 8334 million cubic feet, and adding 35,500 acres to the irrigated area.

In Bengal a project, now being recast, for a canal from the Damodar River to irrigate 196,000 acres was sanctioned in 1921. The estimated cost is 70 lakhs.

In the Punjab no new projects were put forward in the triennium, but those mentioned in the previous Report include some of great magnitude. The Thal project is for the irrigation of land between the Indus and the Jhelum, an area of 1,850,000 acres to be irrigated at an estimated cost of 930 lakhs, or £6,200,000. The Bakra Dam project is for a dam 395ft. high, to store 120,000 million cubic feet on the Sutlej, and a new canal. A rough estimate of the cost is 14½ crores (£9,667,000) and of the area to be irrigated two million acres. The Haveli project, for a weir on the Chenab to irrigate 672,000 acres, is estimated to cost 200 lakhs, or £1,333,000.

In Burma a preliminary estimate, 11·67 lakhs, has been made for a canal to take off the right bank of the Madaya River for the irrigation of 19,000 acres. An estimate of 13·38 lakhs has been made for the remodelling of the Shwebo Canal system and the irrigation of an additional 35,000 acres. The Panlaung improvement scheme is for the control of the floods on that river by the construction of a dam 120ft. in height. The preliminary estimate for works outlay is 34 lakhs.

In the Central Provinces a programme has been drawn up of new works which it is proposed to carry out during the next thirteen years. The Maniari, Arpa, and Agar Hap projects are for the irrigation, respectively, of 80,000, 160,000, and 80,000 acres of rice; the Katni River and Umrar Nala projects for the irrigation of 16,600 and 25,000 acres of rice and some area of rabi; the Bori, Ari, and Chichbund tanks for 9000, 11,000, and 5000 acres of rice; and the Murum Nala tank, 5000 acres. Some further investigation has been made of the Hasdeo project to irrigate about 250,000 acres.

In Bengal the Hijli drainage project, to deal with about 680 square miles of country at an estimated cost of 50 lakhs, is being considered. A part of the work has been executed.

FINANCE AND REVENUE.

The total capital outlay on irrigation and navigation works, including expenditure on works in progress, amounted at the end of the triennium to 8925 lakhs, or about 59½ millions sterling. It may be noted that the sums mentioned above under the heading "Projects under Consideration," and including the largest but by no means all such projects, amount to 6187 lakhs, or over 41 million sterling.

The old classification of works having been superseded, it may be useful to provide a link between the old and the new classifications by presenting the totals for the classes as given in the present and the preceding financial statements. At the end of 1920–1921 the totals of capital outlays, direct and indirect, were in lakhs:—Productive irrigation works, 5890·42; navigation works, 95·19; protective irrigation works, 1172·80; minor irrigation works, 457·06; minor navigation works, 245·75; all works listed, 7861·22 lakhs.

At the end of 1923–1924 the totals of capital outlays, direct and indirect, were in lakhs:—Productive irrigation works, 5433·20; productive navigation, embankment and drainage works, 174·86; unproductive irrigation works, 2952·05; unproductive navigation, embankment and drainage works, 373·56; all works listed, 8933·66 lakhs. The small difference between this total, from the tabular statements and the figure of 8925 lakhs, as stated in the text, need not be considered here. From the tables, the difference between the two grand totals of 1920–1921 and 1923–1924 is 1072 lakhs, or about £7,147,000, representing presumably the expenditure of the triennium.

The gross revenue for 1923–1924 was 1065 lakhs, the working expenses 377 lakhs, and the net return on capital 7·71 per cent. It is pointed out that the capital invested includes considerable expenditure upon three projects of the first magnitude, which contribute nothing in the way of revenue at present. The return on capital invested was highest in the Punjab: 14·63 per cent. in 1921–1922, 15 per cent. in 1922–1923, and 15·85 per cent. in 1923–1924. In Madras Presidency the respective figures were 12·74, 12·77, and 13·70 per cent.; and in the United Provinces, 7·76, 6·96 and 7·45 per cent.

The net area cropped in 1923–1924 was over 223 million acres, of which the area irrigated by Government works was 26·54 million acres, or 11·9 per cent. The estimated value of the crops raised on lands receiving State irrigation is 14,030 lakhs, or nearly one and a-half times the total capital invested, 8925 lakhs. As showing the degree of dependency on State irrigation the following figures are of vital interest. The percentages of area irrigated by Government works in the total area cropped in each province were:—Bengal, 0·4; Bombay Deccan, 1·0; Central Provinces, 2·5; Bihar and Orissa, 3·9; United Provinces, 5·7; Rajputana, 5·8; Baluchistan, 9·0; Burma, 12·5; North-West Frontier Province, 13·8; Madras, 18·9; Punjab, 38·2; Sind, 82·9. The figure for Madras does not include 3 million acres irrigated by non-capital works.

CANAL SYSTEMS.

The mileages of main canals and branches "in operation" during the triennium may be compared with those for the previous triennium in so far as the difference in classification allows. Since the average area irrigated in 1921–1924 was 27·47 million acres and that in 1918–1921 26·77 acres, one may expect some increase in the mileage in operation, but the inclusion, in the report for the last triennium, of large mileages not reported as in operation during the preceding triennium, although the canals in question were then in full activity, makes it impossible to trace the real increases except in some individual cases, for which the report itself may be consulted. The following figures are, however, worth recording.

For 1918–1921 the mileages in operation were:—Productive irrigation works, main canals and branches 12,112; distributories, 34,562; protective irrigation works, main canals and branches, 1005; distributories, 2899; minor irrigation works, main canals and branches, 3009; distributories, 1501; totals, main canals and branches, 16,126; distributories, 38,962. For 1921–1924 the figures are:—Productive irrigation works, main canals and branches, 15,149; distributories, 32,615; unproductive irrigation works, main canals and branches, 4229; distributories, 8343; totals, main canals and branches, 19,378; distributories, 40,958; apparent increases, main canals and branches, 3252; distributories, 1996 miles.

Apparent increases in the mileages of main and branch canals in operation included:—Sind, 2510; and Punjab 674; and distributories, Punjab, 1063; Sind, 287; Deccan and Gujerat, 244; and Central Provinces, 203.

Specific cases of increases in the figures reported are, for main canals and branches:—Sind, miles, Dad Canal, 5; Desert Canal, 22; Jamrao Canal, 50; Sukkur Canal, 128; and Eastern Nara Canal, 35; total, 240. Entries not found in the previous report include:—Fuleli Canal, 1003; Indus, right bank canals, 109; Indus, left bank canals, 194; Shar Canal, 165. In the Punjab, main canals and branches, miles, new entries include Musaffargarh inundation canal, 426; Chenab irrigation canal, 221; Shahpur Canal, 117; and Ghaggar Canal, 44; total, 808. Probably 115 miles, the total for "minor works" in this province in the previous report is included, so that the figures nearly tally. The respective mileages of distributories in the four cases are 685, 135, 118, and 34; total, 972, accounting for most of the increase. In Sind, increases in distributories' mileages are:—Dad Canal, 38; Mahiwah Canal, 87; Jamrao Canal, 10; Shar Canal, 146. In the Central Provinces, increases in the mileages of main and branch canals are:—Waiganga Canal, 28; Mahandi Canal, 27; and Jandula Canal, 250. In the Bombay Deccan and Gujerat, main and branch canals, Chankapur Canal, 6; and Pravara Canals, 47; distributories in those two cases, 11 and 136; and those of the Godaveri Canal, 117. The differences by the tables are within 2 miles of these figures in the case of main canals and branches, and within 20 miles in the case of distributories, in this case.

The report, as a whole, presents a valuable outline picture of the irrigation of India during the triennium, and furnishes a large amount of financial and other data. It may be suggested that specific references might, in future reports, be given to the sources of detailed information respecting works completed and projects which have been studied and are the subjects of reports.

Some Aspects of Friction.

By W. A. BENTON.*

No. I.

IN venturing to write a paper on some aspects of friction, with particular reference to their significance for engineers, the author was prompted to do so chiefly by the readiness of his firm to permit him to make public the results of some work on the static coefficient of rolling friction carried out in his firm's research department.

Centuries of investigation have brought no solution to the physical and chemical problems involved in the phenomena of friction. It is true to say that at the present time the simplest case of what used to be called "solid friction" presents a more puzzling aspect than on that memorable day in 1699 when the young savant Guillaume Amontons astonished the

* Head of Research Department, W. and T. Avery, Ltd., Birmingham. These articles contain the substance of a paper read before the Midland Branch of the Institution of Mechanical Engineers, Birmingham, October 15th, 1925.

French Academy of Sciences by declaring that the friction between the contacting surfaces of two bodies in motion relatively one to the other, or tending so to move, was not dependent, as was commonly supposed, on the area of the surfaces in contact, but was determined solely by the total normal pressure between the surfaces; that, in fact, friction, both static and kinetic, is independent on the intensity of pressure per unit area, and that kinetic friction is independent also of the relative velocity of the surfaces.

That was a startling, and, as we shall see later, a vigorously challenged pronouncement. Amontons, however, was not the first, though all the world thought he was, to make this momentous discovery. About four years ago Sir Arthur Schuster, in a communication to Sir W.B. Hardy,[1] informed him that Leonardo da Vinci first discovered the laws of solid friction, and that in an unpublished note-book he "records how he measured the force required to move a rope when coiled closely into a ball, and when stretched out to its full length, and his astonishment at finding the pull was the same, although the area of contact was so different." Da Vinci lived from 1452 to 1519, so that his work on friction ante-dates the experiments of Amontons by about two hundred years. His experiments, to quote Dr. Ivor B. Hart, "led him to conclude that the amount of friction was independent of the areas of the surfaces in contact; that artificial smoothing or lubrication reduces friction; that for bodies polished or smoothed to an equal degree, the friction is proportional to the pressure between them; and that on a horizontal polished surface the resistance to friction by all bodies is with a force equal to one-quarter of the weight." This last statement, though incorrect in respect of the numerical value of the ratio, does clearly recognise a definite coefficient of friction.

The practical importance of the subject of friction makes it very difficult for the modern mind to understand the total neglect of the subject by the philosophers of the Ancient World. As far as the author is aware, no Greek thinker—not even Archimedes, the first great experimentalist—ever concerned himself for a moment about friction. Such a mundane reality must have seemed to the Greeks a sad interference with the order of a geometrical world of dimensionless points and uni-directional forces. No doubt, too, something of the same spirit animated many of the great mathematical and physical investigators of the Italian Renaissance, who, in so far as they were natural philosophers, were filled with the Greek love of pure reasoning. In such a rarefied atmosphere, there was not much inducement to the investigation of friction, or of any of its allied practical problems. It is the glory of the French Academy of Sciences that from the very first it concerned itself not only with the progress of pure science, but with the useful application of science to the service of mankind. Its practical and essentially modern spirit is seen in the way in which the Academy received M. Amontons' classic communication, and also in the title the author gave to his paper. He announced it as "On the Resistance Caused in Machines by Friction of the Parts of which they are Constituted, and by the Rigidity of the Cords (or Belts) used therein; and on the Means of Calculating Both the One and the Other."

In Figs 1 and 2 photographs of two of the figures

EXPERIENCE

Du Frottement de diverſes matières les unes contre les autres.

On a mis ſur des plans *A A*, de cuivre, de fer, de plomb, de bois, enduits de vieux-oingt: d'autres plans

BB, de pareilles matières & de différentes grandeurs, on les a preſſés les uns ſur les autres différemment par des reſſorts ſemblables à celui repréſenté *CCC*, dont la quantité de la preſſion étoit connue. On a changé ces plans dans toutes les manières poſſibles, mettant tantôt ceux de fer ſur ceux de cuivre, de plomb, & de bois, & tantôt ces derniers ſur celui de fer: & à chaque fois on a remarqué avec un peſon à reſſort *D*, la quantité de force néceſſaire pour les faire mouvoir, & on a trouvé,

Primò, *Que la réſiſtance cauſée par le frottement n'augmente & ne diminue qu'à proportion des preſſions plus ou moins grandes ſuivant que les parties qui frottent ont plus ou moins d'étendue.*

"THE ENGINEER" SWAIN SC.

FIG. 1—FIRST PAGE OF AMONTONS' PAPER ON "FRICTION"

which accompany M. Amontons' article are reproduced by courtesy of the librarian of the Birmingham reference library, which is fortunate in possessing a complete set of the History and Memoires of the French Academy of Sciences. In the official History of the Academy for the year 1699, made by Royal command, the compiler says that M. Amontons first raised the question of the nature of friction in connection with his *Moulin à feu*, or "mill worked by fire." The author has examined the design and description given of this machine, and finds that it consisted of a broad wheel, partly immersed in water and divided into compartments inter-connected across the wheel by pipes fitted with valves, and so designed that the heat of a fire on one side of the wheel expanded the air in the neighbouring compartments, and expelled water from those on the opposite side. As the wheel began to revolve, the heated compartments were cooled, and water was drawn up into them, thus making that side of the wheel continuously heavier than the other side.[2]

There is no evidence that this machine was ever constructed, at least not in a complete model of useful dimensions, and it is only interesting to us as instancing the fact that in M. Amontons we are dealing with a scientific man who possessed the instincts of an engineer, one who, as soon as he became practically aware of the mechanical importance of friction in the operation of a machine, set himself to investigate its laws, and accurately to estimate its effect. He had the characteristic bias of an engineer for practical experiments and useful mathematical data. He performed the experiments—a long, laborious, careful series—and did his best to supply posterity with the figures deduced therefrom.

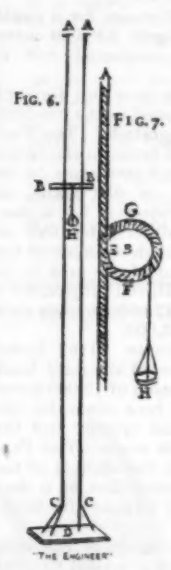


FIG. 2

The chronicler of the Academy refers to Amontons' results as a "novelty," and says that M. de la Hire at once betook himself to experiment to test his conclusions. He found the new Academician was right, and he tried to explain Amontons' law on physical grounds. That is an effort which has been continued at intervals during the ensuing two and a-quarter centuries—without, as yet, finding a satisfactory explanation of the facts.

Amontons, like Leonardo, thought that the coefficient of friction was practically the same for wood, iron, lead and brass, when those substances were anointed with oil or other fatty matter, but that it was equal to about one-third and not one-quarter of the force pressing the surfaces together. It is evident that the members of the Academy entertained some doubts as to whether pressure was the only factor beside the specific coefficient in determining the amount of friction between two surfaces, and in an article on M. Amontons' work in the 1703 volume of the official History, the writer expresses the opinion that for very light pressures the extent of the surface must be taken into account.

One of the first to accept Amontons' results and to attempt to provide an explanation for them was M. Parent, the mathematical physicist. As early as 1700 he forwarded a communication to the Academy in which he assumed that Amontons' explanation of friction as being due to the asperities or roughnesses of the contacting surfaces was correct. Amontons believed that these roughnesses were present, even on the most highly polished surfaces. Parent agreed, and, on the assumption that the ultimate particles of matter were spherical, he imagined that the surfaces of all apparently smooth bodies consisted of countless hemispheres, and that when two surfaces were in frictional contact, these hemispherical projections interlocked with each other. He then showed that the resistance of the surfaces to a force tending to produce relative movement would depend on the total pressure between the surfaces; for, since movement could only take place by a lifting of one set of projections over the other set, or an elastic yielding of the mutually interlocking hemispheres, the number of such hemispheres in mutual engagement was immaterial, as the greater the number, providing the total pressure remained the same, the less was the lifting or the yielding required in the case of each interlocking pair.

This theory has been elaborated and restated by successive physicists, and it is obvious that it can only be true providing that the yielding or displacement of each protuberance is strictly in proportion to the stress to which it is subjected. Sir W. B. Hardy[3] has recently emphasised an almost neglected aspect of this type of explanation by pointing out that it assumes that the actual friction of truly plane surfaces has zero coefficient, or, in other words, is non-existent.

M. Parent's theory cannot stand in the light of modern knowledge—at least, not in the form in which he first stated it—but the author's reading of his ingenious explanation, making due allowance for the lack of exact scientific terminology at that distant epoch, leads him to conclude that this type of explanation has not advanced very much from the position in which it was left two and a-quarter centuries ago. We have replaced Parent's elastic hemispheres by the velvet-like pile of fatty acid molecules, and hydrocarbon chain agglomerations standing on end, sharply oriented with their acid radicles or carboxyl groups firmly anchored to the metallic or other faces of the contacting bodies, but we are still obliged to assume that the displacement of these cillia[4] or elastic projections is exactly proportional to the stress put on them, and that, apart from the horizontal component of the resistance they offer to a surface moving in contact with them in a direction normal to their orientation and tangential to the surface to which they are anchored, no other resistance is presented to the movement of such a surface.

Parent was also the first to attempt to embody Amontons' discovery and law of friction in a system of statics, and in the year 1704, the year before Amontons' unexpected and premature death, he presented to the Academy two articles, entitled "Nouvelle Statique avec Frottemens ou sans Frottemens," that is, a new system of statics taking account of, or neglecting, the effects of friction. These two communications present a remarkably lucid account of the laws of friction in their relation to such simple machines as the inclined plane and the wedge.

Amontons died in 1705, at the early age of forty-two. Ever since boyhood he had suffered from deafness, and Fontenelle, who seems to have written the Laudatory Notice in the History of the Academy, says he appears never to have made any real effort to effect a cure, and that quite probably he rather appreciated this defect, as enabling him more completely to devote himself to his studies and to live a life of greater tranquility. His work in perfecting the thermometer, barometer and hydrometer, not to mention his more theoretical and speculative investigations, was very highly appreciated by the Academy, and was considered to be of outstanding importance. He was the first to develop a system of optical telegraphy, making use of the telescope, and on two occasions, once before the Dauphin and once before Madame, he demonstrated that it was possible on this system to send a message from Paris to Rome in about the time taken to traverse a single posting stage on the journey. For the most part, his name has disappeared from the histories of human achievement, and his great and patient labours have been almost forgotten. Such oblivion is unfair. We must all approve of the suggestion made by Hardy and by Deeley that the chief law determining the friction of bodies, either nominally unlubricated or working under conditions of "boundary lubrication," should be known as Amontons' Law, in memory of its brilliant discoverer.

In the years that followed Amontons' death his work was, in the main, confirmed by Bossut, Belidor, and Bulsinger. Muschenbroek carried out experiments which seemed to suggest that Amontons' results were incorrect. At a later date Camus, Desaguliers and Ferguson supported Amontons, and finally in 1784 and 1785 Coulomb, having repeated Amontons' experiments, both on the friction of surfaces and on that due to the rigidity of ropes and straps, published his results.

Coulomb appears to have done his work as accurately as the state of mechanical science at the time permitted. His experiments left no room for doubt as to the general accuracy of the famous law—which, in fact, for the last hundred years has commonly been supposed to have been discovered and enunciated by him. Coulomb clearly distinguished between the coefficients of static and kinetic friction, and emphasised the specific nature of the coefficients as characterising different substances. He also confirmed Bossut's observations that in respect of all but the hardest substances, the coefficient of static friction increases up to a certain limit with increase in length of time of contact. He mentions a case of two surfaces, presumably of wood, which, on being pressed together with a force of 1650 lb., began to move relatively to each other under a tangential traction of only 64 lb. applied immediately after contact, but required a force of 160 lb. to cause initial movement after three seconds of contact, and a force of 622 lb. to start movement after they had been for six days in contact. All this work was done over again with still greater refinement of experimental skill and mechanical appliances in the years 1831 to 1833 by General Morin, the famous engineer and mathematician. The results of Morin's labours at Metz were published at Paris in a large three-volume work, entitled "New Experiments on Friction." Nothing that has been accomplished since that date has done other than more firmly establish Amontons' Law of Friction as concerning bodies between which friction has reached a steady state.

A more recently emphasised concomitant of the time factor in respect of static friction may here be mentioned. It has been noted by various observers that the kinetic friction of solid bodies generally tends to diminish with increase of velocity, and that at very low velocities the coefficient tends to approximate to that of static friction. The author has himself noted this phenomenon in the moving parts of instruments approaching a state of rest. It has also

[1] Fourth Report on Colloid Chemistry. Article by W. B. Hardy, F.R.S., on "The Theory of Lubrication." Department of Industrial Research. H.M. Stationery Office. 1922.

[2] An enlarged illustration of this machine, carefully drawn and coloured, with an attached descriptive notice in English, is now on exhibition in the Science Museum, South Kensington.

[3] Fourth Report on Colloid Chemistry.

[4] Deeley.

been shown that those substances which, under a given set of conditions, require a longer contact period than usual to attain to their maximum static coefficient are also characterised by requiring a correspondingly high relative velocity before their kinetic coefficient falls to its minimum value. Hardy has pointed out that if kinetic friction be regarded as a function of duration of contact at a point, this relationship is inevitable.

Institution of Naval Architects.

No. III.*

THERE was a large attendance when the meeting was resumed on the morning of Friday, March 26th. The Duke of Northumberland again presided. The first paper to be presented was one by Mr. Harold Yarrow, on "High-pressure Water-tube Boilers for Marine Purposes," which we reprint almost in full on page 411.

Engineer-Vice-Admiral Sir Robert Dixon, opening the discussion, said that the use of higher steam pressures had been forced on the steam engineer for ships of moderate horse-power by the keen competition of the Diesel engine. For ships of over 20,000 horse-power there was no serious menace at the present time to the supremacy of the steam engine. He personally was looking at the matter from a purely naval point of view. The first question which had to be answered was whether it was possible to force a very high-pressure boiler to the same extent as a moderate-pressure boiler and get as good circulation. Then there was the question of the high temperature involved, up to perhaps 900 deg. Fah. The behaviour of metals under a temperature of that order was already the subject of research, and it presented problems of no small importance. In the Navy it was realised that a ship might be lost through condenser troubles and condenser tube drill had been instituted with the object of reducing the time to detect and plug a leaky tube. The entrance of salt into the boiler was another risk which would be increased by the use of higher pressure. Another question arose in connection with the air heater, for which in warships they might not be able to spare the necessary space. There was also a risk associated with the chance that the safety valve might leak or be left open. Mr. Yarrow had referred to the cost of the new type of boiler, but it was also necessary to know how the weight and space occupied by such an installation would compare with that of a boiler of 250 lb. pressure. His own idea was that the increase in weight should be about 10 per cent.

Sir William Ellis said that what was being attempted with these high-pressure boiler installations was an excellent example of that co-operation of the engineer and metallurgist to which he had referred in his presidential address to the Institution of Civil Engineers. The new departure in boiler design raised difficult problems, and he would like to refer to a conference which took place between Mr. Harold Yarrow, a representative of the Board of Trade, and himself, when some novel and important technical questions arising out of the manufacture of high-pressure boilers were fully discussed. One problem which came up in connection with the high pressures and temperatures now proposed was that of creep in metals, which was the subject of research at the present time. As a manufacturer he had one request to make to the engineer. It was not only necessary for the manufacturer to know the pressure the material was to withstand, but also the temperature to which it was going to be subjected. He might be forced into the use of alloy steels which would not only add to the initial cost but would also introduce other troubles for which a remedy would have to be found.

Sir Chas. Parsons thanked Mr. Yarrow for explaining so fully and clearly a boiler which was really a new departure in regard to marine work. The general position was that on land very high pressures and superheating had been successfully employed in connection with turbines both in Europe and in the United States. So far as he was aware there had been no trouble either directly or indirectly with these installations as a result of the pressures employed.

There was no novelty so far as the turbines themselves were concerned, and the conditions at sea were practically the same as those on land. Anyone who studied the lay-out of the new vessel would find scarcely any difference between the turbine equipment and that of an ordinary lay-out at 200 lb. or 250 lb. pressure. The chief trouble to guard against was a rapid influx of salt, and in order to do that a multiple condenser, which would enable the engineer quickly to isolate any particular section, was being fitted.

Regarding the criticism which had been heard as to manœuvring with the new installation, it must be remembered that the amount of water used was quite as much in proportion to the rate of evaporation as it was in the ordinary locomotive. The engine-driver in that case had no difficulty in blowing off steam as required. He hoped to be able, when some trials had been made with the vessel, to read a paper giving the results, but it would not be possible to carry out all these trials until the autumn.

* No. II. appeared April 2nd.

Mr. H. A. Ruck-Keene (Chief Engineer-Surveyor, Lloyd's Register) said that although the working pressure of the boiler, 575 lb. per square inch, with a total heat of 750 deg. Fah., was far in excess of that of any boilers that had been used for marine propulsion hitherto, he saw no reason why it should not, with due precautions, be successful on board ship. The makers had overcome the difficulties in the case of the steam and water drums, namely, the possible leakages of the longitudinal joints of the drums, by forging them. The whole design of the boilers, the superheaters, the arrangement for preheating the air and controlling the supply of steam had been well thought out and appeared to be quite satisfactory. If the claim of the makers that a boiler efficiency of 85 per cent. could be attained was realised in that installation, it would be a great advance on any previous installation on board ship. It was noteworthy that copper had been entirely eliminated in the boilers and their fittings, and steel was to be used in its place, and that the steam pipes were to have thick flanges and metal-to-metal joints. With good workmanship, that plan should ensure steam-tight joints, and provided the pipes were fitted with suitable bends to take up the increased expansion due to the high temperature of the superheated steam, there was no reason to fear any trouble with them. The important problem of preventing salt water entering the boilers had been partly solved by subdividing the condensers so that one of them could be isolated if a leak was discovered. When the trials of the boilers and their turbines had been completed, it would be of great interest if the makers would present a paper to the Institution giving not only the details of the boilers but also of the turbines and the materials used in them, as the question of the material suitable for use with highly superheated steam was one of great importance in connection with increased temperatures.

Sir Archibald Ross said that the advance in the thermal economy of steam-driven plant operated at high pressures had put the Scotch or cylindrical boiler out of the question for service of the kind dealt with in the paper. There were now indications of working at 1000 lb. per square inch with the Yarrow boiler. He noted that the boilers to be fitted to the new ship were of the single-flow type, which was regarded as being most suitable but which raised a doubt concerning the circulation in the non-superheat leg if the boiler were sluggish. There was also the risk of salt and dirty water. With regard to the cost of the new boilers, as compared with the older type working at 250 lb., he thought that in estimating the cost at 20 per cent. higher Mr. Yarrow had been too conservative. An efficiency of 85 per cent. was a capital result. So far the difficulties with materials and joints appeared to have been overcome, but it was interesting to speculate as to what kind of boiler nowadays would be fitted when pressures of 1000 lb. were reached. He would like to know whether any special heat-resisting steel was used in connection with superheater supports or other parts of the boiler. He contested Mr. Yarrow's statement that the building of Diesel engines required greater skill than the construction of steam engines. He mentioned this as it was necessary to correct the wrong impression that Diesel engine construction should be paid for at higher rates than steam engine construction.

Mr. Carlton (Board of Trade) expressed the opinion that although the step now taken was a big one, there was no reason to anticipate steam pipe trouble. Many of the details of construction required careful consideration no doubt, but he took it for granted that the workmanship would be first-class, and that provision for all risks would be made. It had to be borne in mind that higher pressures were being used with success with land installations, and it was inevitable that higher pressures should be employed at sea.

Mr. R. J. Walker said that there was very little that was novel so far as the engines of the ship now under construction were concerned, the only difference from the ordinary turbine ship being that the high pressure was dealt with by a small turbine which took the steam from the boilers at about 500 lb. and expanded it to about 220 lb. Apart from that the installation was just the installation with which they were all familiar. It was expected that the ship would be in service in about three months, but he doubted whether it would be possible to make the elaborate tests which were contemplated before the autumn. It was hoped, however, that it might be possible to have a test or a trial before the ship was placed in service and to give to the engineering world some idea of the efficiencies. There were no new features in the auxiliaries, because the builders had not sufficient data to make any change, but they were designed to withstand boiler pressure up to 550 lb.

Mr. W. H. Patchell, who showed a series of lantern slides of high-pressure boiler installations in the United States, said that boilers were worked at as high a rating in Great Britain as in America. The only difference was that over here engineers did not talk quite so much about it.

Sir Archibald Denny said the ship in which the high-pressure steam installation was to be fitted would represent an advance in design quite apart from her engines and boilers. The vessel was being fitted with twin screws, and as she was of shallow draught they were taking risks of which, however, they were well aware. A notable feature of the experiment which his firm and Messrs. Parsons were anxious to bring before the public was that the new vessel was a coal-burning ship.

Mr. Arthur Spyer agreed as to the importance of improving the efficiency of a steam engine installation for which coal was used as fuel. He thought perhaps Mr. Yarrow was somewhat optimistic in speaking of an efficiency of 85 per cent. for a marine boiler. Efficiencies of that order could be obtained on land where weight and space considerations were less important, but on board ship the weight and space occupied by machinery were prime considerations. He did not think there would be any difficulty with regard to the steam joints, but it might be an advantage to use an alloy steel for superheater tubes. The real difficulty, however, with high-pressure installations was not in connection with the boilers or the steam pipes, but with the boiler mountings, and the question of water gauges was, he feared, going to prove a difficulty.

Mr. Harold Yarrow, replying to the discussion, said in reference to the question which had been asked by Sir Robert Dixon as to the rate of circulation, that if the pressure were higher it was possible that the tubes next to the fire would remain full of water, rather than that it should be turned into steam, and there was no anticipation on the part of the makers that the circulation was likely to be inferior. He did not see why the boilers should not be forced to the same extent as those at 250 lb. As regarded creep, there was the suggestion that they were approaching the dangerous limit, but it must be remembered that the temperatures suggested were by no means new. They were now somewhat common practice in land installations, and no trouble had been experienced. It was desirable, however, that further investigation should take place regarding the question of creep, and work on the subject was now in hand at the National Physical Laboratory.

He was rather at a loss to understand why Sir Robert thought there would be more danger to be apprehended from salt in the boilers at 575 lb. than at 250 lb. Concerning the question of weight and space, his suggestion was that the reduction in weight of fuel which it was necessary to carry might well be an important factor in equalising matters. He was hopeful that evaporation tests and data of ultimate efficiencies would be taken at the trials of the ship, and that the figures could be embodied in a paper to be read at a later date.

The 85 per cent. efficiency which was mentioned in the paper was obtained when the rate of evaporation was about 7 lb. of water per square foot of heating surface. It was encouraging to find that Mr. Ruck-Keene, speaking with the authority associated with his position, saw no valid reason why high pressures should not be used in marine work. Reference had been made to the risk of sluggishness, but his reply was that similar boilers had been used in power stations designed for a rate of evaporation somewhat higher than was proposed for the new ship, and there had been no trouble arising from sluggish circulation. Mr. Spyer suggested that he had estimated the increased cost of high-pressure boilers on too conservative a basis, but he was quite prepared to make a compromise and call it 20 per cent. The additional expenditure would be well worth while, taking into account the fact that a higher quality of steam would be produced. He was quite sure that the higher price would not prevent the adoption of the system. It might be necessary in naval practice to use a higher quality of steel. With regard to what Sir Archibald Denny said in connection with the use of coal as fuel he agreed that it was necessary to push the use of coal for all we were worth.

Engineer-Captain L. M. Hobbs then read a paper on "Some Recent Modifications to Water-tube Boilers of the Three-drum Type Fitted in H.M. Navy."

SOME RECENT MODIFICATIONS TO WATER-TUBE BOILERS OF THE THREE-DRUM TYPE.

As a result of experience in H.M. ships during and after the war, certain alterations in detail have been made in three-drum water-tube boilers. In this paper a brief description of the various modifications, with illustrations, is given. With regard to the steam drums in the Yarrow type of boiler, the caulking of the edges of the internal butt straps is now done away with, and they are bevelled to prevent moisture lodging on them when the boiler is emptied. The external downcomer pipes fitted to the boilers of early design are now omitted, and the scum pan and its fittings have been done away with. The length of the boiler's drum has thus been reduced, and a saving made of 2 per cent. in weight. A description is given of the various methods employed to stiffen the lower water drums, which, prior to 1914, were oval in shape. Struts and stays proved ineffective, and in all new boilers water drums of circular cross section, with double butt-strapped joints, are used. The fitting of the circular drums increases the weight slightly—about 2·5 per cent. for the same power—and the slightly shorter tube length reduces the heating surface on an average 6 to 8 per cent. Various modifications in the setting of the tubes are described, and the special arrangement of fire-row tubes is illustrated. Experiments made by the Admiralty in 1921 indicated that the velocity of flow at the entrance to the 1¼in. diameter fire-row tubes of a Yarrow boiler increased as the rate of the burning of oil increased up to about 0·5 lb. of oil burned per square foot of heating surface per hour; but, after that point, up to a rate of burning of 1·1 lb. per square foot per hour, the velocity of the water remained steady, and had a maximum value of 2·92ft. per second. In the second fire-row the maximum water velocity was 1·5ft. per second when burning oil at the rate of about 0·6 lb. per square foot of tube surface per hour; but that velocity fell off as the rate of forcing increased until at full power—approximately 1·2 lb. of oil per square foot of heating surface per hour—the apparent velocity did not exceed 0·9ft. per second. With regard to the feed arrangements, feed baffles have been done away with, and the feed enters the drums through a long internal perforated pipe with its end blanked off.

The distortion of tubes, it has been found, may be caused by

improper adjustment of the steam drum stays or the boiler feet. It is important that efficient arrangements be made for the free expansion of the boiler feet, and various methods of providing for this necessary expansion are described and illustrated. Another modification made during the last few years concerns the greater portability of the front and side boiler casings. Owing to the restricted spaces on the lower corners of the wing casings, the lower ends of the wing casings are not easy of access, and in some cases where damp had descended from funnels or leading stop valves, a number of tubes had been found to be nearly perforated, owing to a damp coating of soot which had remained unnoticed. Portable panels are now fitted with drain plugs to remove any moisture which may accumulate. The changes described in this paper do not include any arrangements now under trial or still in the experimental stage.

Engineer Vice-Admiral Sir George Goodwin, who opened the discussion which followed the reading of the paper, said that the author referred to the omission of the down tube as having no effect on the boiler, and although that was true, it must not be taken to apply to all boilers. The supply of sufficient water for the generating tubes was of the utmost importance. He thought experience would justify the fitting of the D-shaped pocket. A great source of trouble had been relieved on one occasion by the suggestion of Sir Alfred Yarrow that covering plates should be employed. He hoped the author would supplement his paper with a further contribution giving details on a number of other points of interest and importance on which information had been collected. One point concerning which additional knowledge was desirable was the corrosion due to soot accumulation, which there was reason to believe was caused by sulphur.

Mr. W. Marriner said that the paper was unique in giving the result of experience in actual service of a large number of installations. It was most satisfactory to know that so little trouble has been experienced with the Yarrow boiler, although boilers of that type provided 95 per cent. of the power which was used afloat by the British Navy in the war. In these days of increasing pressures the Yarrow boiler would be suitable for the merchant ship, and any difficulties of the kind described in the paper would disappear at the rates of evaporation customary in merchant practice. In the development of the boiler the manufacturers had been indebted to the Admiralty for assistance and encouragement. Captain Hobbs showed that any trouble which had been experienced was due either to the nature of the steel which was used, or to the bad treatment which the plates received during the process of manufacture, such as local heating and working after pressing or too heavily caulking the seams. It had been the practice of his firm to avoid caulking or any heating or working of the plates after pressing, and every care was taken to make the joints as perfect as possible by carefully machining all the plates to an accurate fit. Referring to the minimum length of the expanded portion of the wing tubes in the tube-plates, in many boiler shops a satisfactory joint could be made if the width of the expanded portion was not less than ¼in. There were many locomotive boilers working at pressures between of from 200 lb. to 250 lb., in which the tubes were made tight on surfaces between ¼in. and ⅜in. wide, and in the case of the locomotive tube-plate the bearing surface was not backed by much thicker metal than in the case of water-tube boilers. With regard to the setting out of the tubes in the fire-rows exposed to the radiant heat, the general impression seemed to be in favour of a uniform pitch and, not having V lanes, mainly because a V lane reduced the heating surface in a given space.

One result of Sir Alfred Yarrow's classic experiments on velocity of circulation carried out in 1896, was to prove that the higher the steam pressure within limits and consequently the smaller the bubbles of steam, the greater would be the safe maximum rate of working. In some later experiments 145 lb. of water were evaporated from and at 212 deg. Fah. per square foot of heating surface. In three boilers, each of 10,000 horse-power, water was evaporated at an average rate of 22 lb. per square foot without the slightest evidence of having reached the limit of working, so that a proposed rate of about 7 lb. for the mercantile marine would give the maximum economy and unlimited endurance. With regard to passing the feed into the last three rows of tubes, so that those tubes would act as feed heaters, the first experiments in connection with that plan were made with the help of the late Professor Lambert of the Greenwich Naval College. Manufacturers were fully alive to the bad effect of introducing cold feed into water into boilers, and that method of feed heating had been replaced by direct contact or by surface feed heaters using the auxiliary exhaust. In modern installations the heat in the waste gases was taken up by air heaters. As regarded the method of supporting the boiler and the provision of sliding feet, that was of importance, and in land boilers, where there was an overhead structure, the boiler was supported from the steam drum, a method which allowed the water drums free movement in every direction. The best way to preserve a boiler when not under steam was to provide ample ventilation, so that the temperature of any part of the boiler did not fall below dew point. If one boiler in a closed stokehold was laid off it was advisable to leave some openings to circulate the air through the uptakes of the boiler; the amount of extra work thrown on the fan was negligible. The last paragraph in the paper was very suggestive, and it was hoped that Captain Hobbs would at an early date be able to give the results of the experiments which the Admiralty had carried out recently.

Captain Hobbs, replying to the discussion, referred to requests for information on later developments than those dealt with in the paper, but said that he was not authorised by the Admiralty to give any further information at the present time. He could say, however, in answer to Sir George Goodwin's question about external corrosion, that it was not due to sulphur in the soot deposits. Mr. Marriner had referred to the question of the movement of the water drums. The suggestion that they might be allowed to swing the steam drums from the decks and leave the water drums to expand was, he was afraid, almost an impracticable solution from a naval shipbuilding standpoint. It was possible that at a later date more information would be available as to the results of research work at the Admiralty.

The first paper on the agenda for the final session of the meeting, on the afternoon of Friday, March 26th, was one by Mr. A. W. Cluett on "The Method used in H.M. Ships for Readily Correcting Heel and Trim."

ON THE METHOD USED IN H.M. SHIPS FOR READILY CORRECTING HEEL AND TRIM.

Arising out of experience during the war, it was considered that the organisation in H.M. ships for correcting heel and trim caused by flooding of compartments, due to damage in action or by other means, required elaboration and standardisation. It was therefore decided to issue to all battleships, battle-cruisers and cruisers sufficient information to enable this correction to be carried out readily by officers detailed for this duty. Each ship is accordingly supplied with drawings showing her underwater compartments and spaces. These are mounted on a wooden board, which is known as a "flooding board."

The flooding board gives plans of all deck and hold spaces below the water line of the ship concerned, and includes every underwater compartment. Each compartment on the board is marked by figures which show the effect on the ship, as a whole, caused by the separate flooding of the particular compartment.

The positions of all flooding sea cocks, permanent flooding pipes and valves are shown diagrammatically on the board. Those compartments which may be flooded by portable hose, and the connection from which the hose may be led, are also indicated.

Two plans for the case of a small warship are given in the paper.

The executive officer is reponsible under the captain for recording on the board the compartments flooded, and for issuing orders for the flooding of other compartments necessary to restore the vessel to her original trim and upright condition. Arrangements are made for the staff to be trained in the flooding operations, so that in case of emergency the necessary corrections are smoothly and rapidly carried out.

Regarding the utility of supplying similar boards to merchant ships, it is necessary to consider the various types separately. Such ships are not so finely subdivided as warships. The conditions are also different, it being essential in a warship, if she is to remain an effective unit, that the change of trim and heel be minimised. In a merchant ship the presence of a comparatively large heel or trim might perhaps be temporarily accepted, being limited generally by freeboard and the probability of cargo shifting. The holds are large and correction of heel and trim by flooding other similar spaces may be prohibitive from a stability and freeboard point of view. Moreover, the hold may contain cargo of a permeability which varies from time to time, and which will accordingly complicate the flooding board. The modern large passenger ship, however, more closely approaches the warship, both as regards subdivision and constancy of permeability of contents. Accordingly, whilst in the cargo class of vessel the flooding board may not be of great use, and a tabular statement should supply all the necessary information, yet in the large passenger ship the flooding board would probably prove of assistance in case of emergency.

Mr. W. J. Berry, opening the discussion, said that every detail of battleship design was settled on the assumption that the ship would be floating in an upright position at a suitable trim. It was clear that any appreciable heel or departure from the correct trim had the effect of introducing difficulties in the working of the ship. The operation and control of the guns and torpedo tubes was at once affected, while the protection given by the vertical armour was lessened, if the ship was not upright, as any pronounced heel exposed the unprotected portion of the hull, and made the ship more vulnerable to enemy attack. The navigation of the ship was also rendered more difficult. For those reasons the Admiralty had been forced to evolve a system by which, within reasonable limits, changes in heel and trim could be dealt with and a remedy provided, and, of course, a system having the same objects was used in other navies. There was good reason to believe that during the war a number of enemy ships were only able to reach port by the employment of methods of flooding similar to that described by Mr. Cluett. A less elaborate, but reasonably effective method of doing the same thing had been worked out by officers serving at sea. For that system plans were made showing the various water-tight compartments of the ship and the sinkage, trim and heel data for every compartment, and the commanding officer was kept informed in case of damage to the ship of the proper course to pursue in regard to flooding. That service method was occasionally rehearsed at sea, and it was found that it could be operated in a minimum of time, a rate of correction of about 5 deg. being effected in about fifteen minutes.

Professor Carter said that Professor Hovgaard, in his book on warship design, had dealt with the same subject, but his own opinion was that Mr. Cluett's figures were to be preferred. The latter certainly agreed quite closely with those drawn up by the International Convention on Life Saving, when allowance was made for the difference between war and merchant ships.

Lieut.-Colonel C. Tennyson expressed the opinion that no flooding system would be able to counterbalance the rate at which water would enter a ship damaged during a naval engagement, and a quicker method must be sought. Something of the kind had been attempted when the cruiser Rurik was built by Messrs. Vickers for the Russian Navy. As the result of experience gained during the war with Japan, means were provided for the rapid flooding of four compartments—two forward and two aft.

Sir Archibald Denny questioned whether the flooding system described in the paper could be applied to merchant ships, which were not so closely subdivided as warships. The increasing use of oil fuel was, however, having the effect of forcing a greater degree of subdivision on ship designers, and it was possible, therefore, that it might be less difficult in future to arrange for the adoption of a system of the kind described in the paper for merchant ships.

The last paper on the agenda was one by Mr. Ebenezer Smith, "The Crane Equipment of Shipbuilding Berths."

THE CRANE EQUIPMENT OF SHIPBUILDING BERTHS.

This paper is part of a scholarship study by the author on "The Lay-out and Equipment of Shipyards," notes of which are at the disposal of the Institution and will probably be published in book form. The survey of the various types of berth crane systems is based upon visits to British and continental shipyards, and it is rendered more valuable by the fact that prices on a 1925 basis are given for the total cost of each type of equipment, including for the first six types, provision for the transportation of material by rail. For the purpose of comparison, a six-berth yard, having an average length of 500ft., is taken, and nine different types of equipment are considered in detail.

In the discussion Mr. W. J. Luke, referring to the difficulty of making a choice of crane equipment to meet conditions in shipyards, said that a dominating factor was the knowledge that in normal shipbuilding operations provision had to be made for a large number of moderate lifts, and it had to be remembered that "hanging on" was a somewhat frequent occurrence. He would like to emphasise the point that crane equipment should be regarded as labour-aiding rather than labour-saving machinery, and that it really called for special skill and unremitting attention on the part of the operator if the most effective use was to be made of it. It did not displace labour, but enabled more work to be done.

Mr. Hamilton Martin dealt with practice in foreign shipyards, and referred to satisfactory experience of an old installation of stationary hammer head tower cranes which served two adjacent 550ft. berths, and which were capable of lifting loads from rail alongside and of reaching right over the building slips. Those cranes, which had given good service over a considerable period, had not cost more than £2000 each at the time they were installed, but would probably cost at least twice that sum to-day.

Professor Carter referred to the work done by Mr. Smith as an excellent example of the service which was being rendered to the shipbuilding industry through the research scholarships awarded by the Institution.

Mr. Cluett, who dealt with practice in the Royal Dockyards, said that the equipment consisted to a large extent of the old derrick type of crane which appeared to meet all requirements quite satisfactorily. In ship construction it was necessary to keep in mind the fact that crane equipment must be designed for a large number of lifts and to put material in any position. The paper contained a large amount of information, and should prove valuable to those engaged in shipyard management.

Mr. Ebenezer Smith, in reply to the discussion, said that as a result of visits to a number of shipyards at home and abroad, his own choice lay between the cableway and the overhead travelling crane. If one had to admit that foreign yards possessed more modern equipment than the majority of British shipbuilding establishments, that was because most of the foreign yards were newer. He was in agreement with the statement by Mr. Cluett as to the efficiency of derrick equipment. He had had an opportunity of seeing two yards on the Clyde, both belonging to the same company, one fitted with derrick equipment and the other with tower cranes. It had been shown by experience that the derrick system was as cheap to operate and quite as efficient as the tower crane.

Sir Archibald Denny, the chairman, in concluding the discussion, said his own preference was for the overhead crane, which was a most useful piece of handling plant, and only required one man to operate it. His firm had installed two cranes of that type to serve a 500ft. berth, and they had given most satisfactory results, although it must be remembered that the cranes had not yet been subjected to the searching test of a really busy period.

Mr. R. W. Dana (secretary of the Institution) said he would like to express the thanks of the Institution to those shipbuilders at home and abroad who had given facilities for Mr. Smith, as holder of one of the Institution research scholarships, to inspect their yards and had given him a great amount of useful information.

That terminated the business proceedings of the meeting. Votes of thanks were accorded to the Duke of Northumberland as President, and to the Society of Arts for the use of its rooms.

The new steam turbo-generators which are to be installed at the East River plant of the New York Edison Company are to be of 80,000 horse-power each.

Some Special Steels.

ON the occasion of a recent visit to Sheffield, we had the good fortune, on going round the Hecla Works of Hadfields, Ltd., to see various applications of several new steels, which are being made at those works, and although the characteristics of these steels are already known to some engineers, their merits are sufficiently remarkable to warrant some extended notice, while the fact that Hadfields name is so intimately associated with manganese steel is liable to overshadow these newer products of the works.

It will be noticed that we refer to steels in the plural, as there are several in the group, each with distinct characteristics, although those that have met with the more important engineering applications are similar to the extent of having an austenitic structure; that is to say, they are solid homogeneous solutions which are able to maintain their physical properties at all temperatures to a degree hitherto unknown. In the production of these steels Messrs. Hadfields have been associated with the French company, Société Commentry Fourchambault et Decazeville, a company of which Reaumur wrote so long ago as in

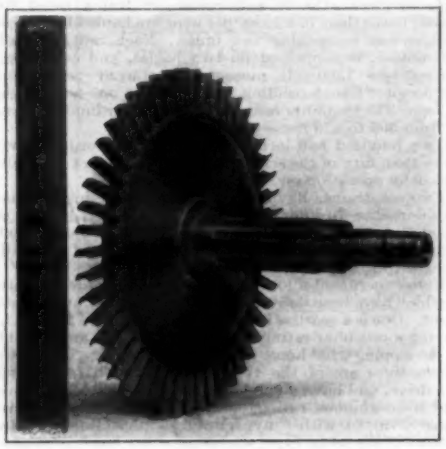


FIG. 1—ROTOR FOR EXHAUST GAS TURBINE

1722 that he could rely on the accuracy of the work carried on there. The precise composition of these steels is, obviously, not disclosed by the makers, but it may be said that they are based on the nickel chromium class.

The several qualities of steel under review may be broadly described as being specially resistant to heat, to oxidation and to corrosion, and it is difficult to chose among them which is the most interesting to engineers in general. The example shown in Fig. 1 is, however, of outstanding merit, as it indicates the possibility of the ultimate realisation of the aim of so many investigators—the gas turbine.

It is the rotor of a machine driven by the exhaust gases of an internal combustion engine, and has worked continuously at a temperature of from 800 deg. to 900 deg. Cent., when running at a speed of 30,000 revolutions per minute. It has, in fact, been run up to a speed of 53,000 revolutions per minute for testing purposes, and the peripheral speed was then some 2200ft. per second. In these circumstances the metal would be almost red hot, and that it should be able to withstand the centrifugal force produced at that speed is good augury for those interested in the construction of internal combustion turbines.

The characteristics of the steel of which this turbine rotor was made, which is known as "Era A.T.V." steel, are perhaps best demonstrated by tests carried out in the makers' works, which indicate a loss of only about two-thirds of its strength when heated up to red heat. In other words, the maximum tensile stress the material will sustain at normal temperature is 58·5 tons per square inch, while it is 19 tons at 900 deg. Cent. It might be contended, however, that although the steel would withstand such a stress sufficiently long for an ordinary test to be carried

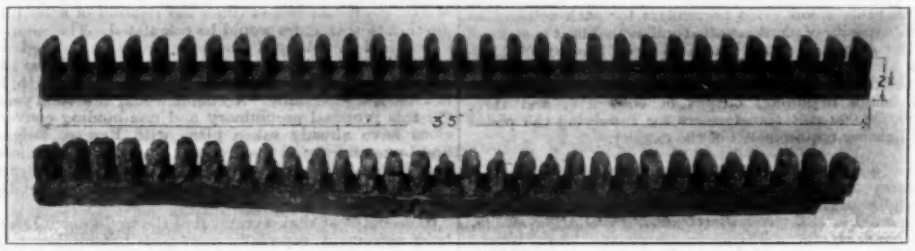


FIG. 2—CAST STEEL RACKS OF SPECIAL AND ORDINARY MILD STEEL

out, it would, at these elevated temperatures, become more or less viscous and tend to creep. Creep-stress tests show, nevertheless, that up to 700 deg. Cent. at least, the stress which the metal will support indefinitely is as much as 11 tons per square inch. At this temperature the creep-stress of ordinary 0·3 per cent. carbon steel is less than 1 ton per square inch. It is thus obvious that unless a very high factor of safety is demanded, this steel can be used with normal designs in circumstances where it will be maintained at nearly a red heat.

The makers claim that this steel is readily machinable, and the engraving—Fig. 1—shows that it can be turned, milled and have screw threads cut in it, and we believe that with some little experience on the part of the machinist the best method of cutting is readily determined.

Another member of this series of steels, which has been named "Era A.T.V.," is specially applicable to services where it will be subject to high temperatures in a scale-producing atmosphere, and is employed in the Hadfield works for such purposes as the racks used to hold leaf springs in hand-worked furnaces. An example of such a rack is illustrated in Fig. 2, together with one made of ordinary mild cast steel. Both these racks had been in service in a furnace at a working temperature of 900 deg. Cent., the mild steel specimen for a period of twelve weeks,

FIG. 3—CHAINS OF HARDENING FURNACE MADE OF SPECIAL STEEL

and the Era rack for nine months. No comment is necessary as to the relative endurance of the Era rack shown in the upper part of the illustration. It is noteworthy, however, that while there are other steels, with somewhat similar characteristics which persist up to a certain temperature, there is a limit above which they rapidly fail, while the Era steel maintains its non-scaling qualities up to a very high temperature. Chromium steel, for instance, wastes away through scaling very little faster than Era steel up to a temperature of 850 deg. Cent. When, however, the temperature is raised to 1000 deg. Cent., we are informed, the scaling of the chromium steel amounts to 7·31 grammes per 100 square centimetres in three hours, but that of the Era steel has hardly increased at all, and is 0·03 gramme. It is suggested that this non-scaling property is due to the production of a protective coating on the metal, an idea which is supported by the fact that during the first fifteen minutes the loss by scaling amounts to 0·01 gramme, while the average per quarter-hour during the three hours is 0·002 gramme. For these reasons the metal is specially applicable to a variety of other purposes, and we noticed that some of the muffle furnaces used in the laboratory at the Hecla Works are cast in it, while a variety of other applications—such as pyrometer tubes, mechanical pokers or agitators for gas producers, which can be kept in useful service without the assistance of water cooling—will occur to most engineers.

Fig. 3 illustrates perhaps one of the most severe tests to which a material of the class under review might be subjected. It represents a furnace used at the Hecla Works for heating spring leaves in a hardening furnace. The leaves are carried through the furnace by continuously moving chains, which are furnished with comb-like teeth. The teeth are alternately subjected to the furnace temperature of 950 deg. Cent., and to that of the atmosphere on the return journey. On the occasion of our visit, however, the teeth did not show any signs of distress, although we were informed that they had been in service for some six months.

Although there are several other variations of this range of steels, each devised to meet peculiar requirements, we will confine ourselves on the present occasion to reference to one other, and, incidentally, it may be mentioned that this variety is really the precursor of those which we have described above. This quality of steel is known as "Hecla A.T.V.," and was primarily produced for making the blades and nozzles of steam turbines. It is easily machined, and can be got up with a high degree of finish, but, unlike some forms of anti-corrosive steel, does not depend for its resistance on the polish of its surface—that is to say, the absence of incipient cracks. In view of the homogeneous nature of the metal, it is immaterial as to whether its surface is disturbed accidentally or not as its resistance to corrosion remains the same. Besides this, the austenitic character of the steel gives it the advantage that special heat treatment is unnecessary, and it can be handled with impunity and in a variety of different ways during the processes of construction. Turbine blades can, for instance, be cast into diaphragms, without influencing the character of the metal, they can be brazed in place if required, and can be riveted over for the attachment of shrouding.

The mechanical strength of this steel is good at normal temperatures, but, as will be seen from the table below, one of the most striking characteristics is the maintenance of a useful tensile strength at temperatures well above any now in vogue in steam turbine practice. It has a Brinell hardness of about 200, while its resistance to shock by the Frémont notched bar test is 8 kilogramme-metres and the Izod impact test shows a resistance of about 40 foot-pounds.

Tensile Tests of "Hecla A.T.V." Steel.

Temperature, deg. Cent.	Yield point, tons/sq. in.	Max. stress, tons/sq. in.	Elongation, per cent.	Reduction of area, per cent.
15	30	50	20	35
450	26	42	18	28
500	24	39	20	30
600	17	26·5	24	35
650	14	20·5	27	52

In view of the necessary resistance of turbine blading material to vibration and fatigue, the following figures, with which we have been supplied by the makers, are given to indicate the quality of the "Hecla A.T.V." steel in this direction:—

Alternating Stress and Fatigue Tests on "Hecla A.T.V." Steel.

Tests taken on.	Tensile test.					"Wöhler" type fatigue test. Fibre stress, 27 tons/sq. in.	
	EL.	YP.	MS.	El.	RA.	Revs.	Brinell.
1¼in. dia. bar ..	26	36	54·1	28	44·6	163,980	206
1in. dia. bar	26	34	52·0	35	47·9	180,600	182
0·5% carbon steel, quenched and tempered	30	32	55·0	19	34·0	55,771	217

The tensile tests of which the results are given above were of the usual short-duration type, but in actual service the metal must, of course, be capable of withstanding the working load more or less indefinitely, and it is a well-

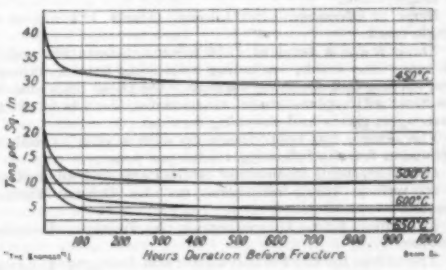


FIG. 4

known fact that at high temperatures ordinary carbon steel fails in this direction. Some extensive tests were consequently made with the "Hecla A.T.V." steel to determine its resistance under sustained tensile stress and high temperature, and the results of these experiments are given in the form of a graph in Fig. 4. It will be noticed that the stress necessary to cause fracture falls very rapidly at first, but the curves soon flatten out and suggest that at a lower stress the load may be applied almost indefinitely. Assuming, for instance, that the working temperature is 600 deg. Cent., and a factor of safety of 2 is used, the curves show that a stress of about 2 tons per square inch could be safely adopted.

One of the most important properties which a blading metal should possess is, of course, good resistance to the corrosive and erosive effect of the steam, and it appears that the steel under review has this character to a marked degree, although it is difficult to give a quantitative estimate. The photograph which we reproduce in Fig 5 may, however, help to illustrate the matter. This engraving represents part of the blading, made of 5 per cent. nickel steel, in a 5500-kilowatt turbine, which had been in service for 20,400 hours. The conditions were certainly

severe, as the feed water was not altogether satisfactory, but it is evident that the blading metal was quite unsuitable and the efficiency of the turbine must have been very seriously affected. On the other hand, another turbine bladed with A.T.V. steel, which incidentally was situated at a coastal station, was opened up after more than five years' running, and as there were no indications of the least wear and tear, it was shut up again to go on load. Unfortunately, as a consequence, no illustration for comparative purposes with Fig. 5 is available, but Messrs. Hadfields assure us that had a photograph been taken it

FIG. 5—WEAR OF NICKEL STEEL TURBINE BLADES

would have been indistinguishable from one of new blading.

Besides the three new steels which we have described above, several others possessing somewhat similar characteristics to a lesser degree, and consequently not so costly, have been recently evolved at the Hecla Works, while another group specially resistant to the corrosive action of acids and chemicals has been produced; but enough has been said to show that the researches carried out there are leading towards the development of new materials of the greatest utility to engineers.

Electric Traction on the Orleans Railway.*

Of the railway lines from the Central Plateau to Paris, those which the Orléans Company proposes to electrify first are the lines having the greatest density of traffic, and, consequently, the biggest consumption of coal.

It can easily be shown that the greater the coal consumption per mile of line, the more favourable will be the financial results of electrification. For this reason and others the company, after having investigated with the Government the question of commencing the electrification by converting to electric traction the lines in the neighbourhood of the waterfalls of the Central Plateau, eventually decided to carry out the electrification in the following order :—

Paris to Brive.—A length of 502 kiloms. (about 312 miles), of which 65 kiloms. (40½ miles) comprises four tracks, and 477 kiloms. (297 miles) is double track.

Brétigny to Dourdan.—27 kiloms. (about 17 miles) of double track.

Saint-Sulpice to Gannat.—190 kiloms. (about 118 miles) of single track.

Brive to Clermont.—198 kiloms. (about 123 miles) of single track.

These make a total of 1576 kiloms. (about 980 miles) of main line track, excluding switching tracks, sidings, and sorting and shunting stations. On these lines electric traction will replace steam traction for the whole of the passenger, goods and shunting services.

The scheme has been drawn up with a view to making provision for the following traffic per year :—

40 million tonne-kilometres[1] on the Paris–Orléans section.

20 million tonne-kilometres on the Orléans–Vierzon section.

12 million tonne-kilometres on the Brétigny–Dourdan section.

The orders for the Paris–Vierzon and Brétigny–Dourdan electrification, involving the equipment of over 600 kiloms. (370 miles) of main line track, have all been placed since 1923. Already a number of electric trains are running from Paris (Quai d'Orsay) to Etampes and from Brétigny to Dourdan, a total length of 96 kiloms. (59½ miles) of route, and the electric service will be extended as far as Orléans and Vierzon before the end of 1926.

Electrification of the Paris–Vierzon Section.

The electrical energy is generated as three-phase alternating current in a system of power stations comprising at present :—

(1) The steam power stations of the Paris district, namely, the Gennevilliers power station (250,000 kW)[2] and the Vitry power station (80,000 kW) of the Société l'Union d'Electricité.

(2) The water power plant of Eguzon on the river Creuse, which has a capacity of 50,000 kW and belongs to the Société l'Union Hydro-Electrique, in which the Orléans Company holds an interest.

(3) A group of water power stations forming part of the concession granted by the State to the Orléans Company. These stations can supply throughout the year an average demand of 100,000–150,000 kW, depending on their equipment. Two plants, those at Coindre (20,000 kW) and Chavanon (25,000 kW) are in course of erection. A third, that at Marèges, of 100,000 kW capacity, is under consideration.

The unavoidable fluctuations in the output of the water power stations will be completely compensated, in the case of the plants on the river Creuse, by the exchange of power between the Eguzon water power plant and the Gennevilliers steam plant, and in the case of the Haute-Dordogne plant by means of the Chavanon reservoir and by the exchange of power with the Alpine hydro-electric stations.

Transmission of Power.—The power generated in the various hydro-electric and steam power stations will be transmitted as follows :—

At 13·5 kV by three three-phase cables, of 150 square millimetres section per phase, from the bus-bars of the Vitry steam plants to the Paris and Ablon sub-stations of the Orléans Company.

At 60 kV by three groups of three single-phase cables, of 150 square millimetres section per phase, the pressure between each phase and earth being 35 kV, from the bus-bars of the Vitry power station (two groups of cables) and from Gennevilliers (one group of cables) to the bus-bars of the Chevilly sub-station of the Paris–Orléans Company.

At 90 kV by two three-phase overhead lines, of 238 square millimetres section (aluminium cable with steel core) and about 300 kiloms. (186 miles) in length, from the bus-bars of the Eguzon power station to those of the Chevilly sub-station, passing through the fifteen traction sub-stations situated along the line from Paris to Eguzon. These lines will be extended to Souillac to feed the seven sub-stations which distribute current for traction between Eguzon and Brive.

At 150/220 kV through an overhead line connecting the four transformer sub-stations of Chevilly, Chaingy, Eguzon and Vernéjoux.

At 120 kV through a line connecting the power stations of the Central Plateau to the Alpine stations, and following approximately the proposed line under consideration from Commentry to Saint-Germain les Fossés (new section of the Bordeaux–Lyons line).

Transformer Sub-stations.—The transmission lines working at 60 kV, 90 kV, 120 kV, and 150 kV, will be interconnected through five transformer sub-stations, situated respectively at Chevilly, Chaingy, Eguzon, Vernéjoux, and Commentry. The Chevilly sub-station connects the 60 kV system of the Société l'Union d'Electricité to the 90 kV and 150–220 kV systems of the Orléans Company, by means of three banks of static transformers, having a total capacity of 75,000 kW, namely :—Two banks of 25,000 kW, transforming the current from 60 kV to 90 kV, or *vice versâ*; and one bank of 25,000 kW transforming the current from 60 kV to 150 kV, or *vice versâ*.

This sub-station is intended to receive later three further lines at 150–220 kV, and eventually two extra lines at 90 kV.

The Chaingy sub-station is a sectionalising, transforming and regulating sub-station. It contains two banks of static transformers, each bank having a capacity of 20,000 kVA. These transformers, of which the two high-tension windings at 150 and 90 kV are star-connected, carry a third winding delta-connected at 6 kV. These 6-kV windings feed the synchronous condensers, each of which is able to supply a maximum reactive power of 10,000 kVA, the current leading or lagging according to the excitation. This sub-station is intended to receive in the future two 90-kV lines which are to be erected in the direction of Tours, and seven extra outgoing feeders at 150–220 kV.

The Eguzon sub-station connects the Orléans Company's 90-kV and 150-kV systems through the intermediary of the 10,000-volt bus-bars of the Eguzon power station. The sub-station contains three banks of transformers totalling 25,000 kVA, namely, two for transforming from 90 kV to 10 kV, and one for 150 kV to 10 kV. The plant for the Marages and Commentry sub-stations has not yet been ordered.

Rotary Transformer Sub-stations.—Three-phase current at 50 periods is transformed to direct current at 1500 volts at eleven sub-stations, representing a total capacity of 54,000 kW for the sections Paris to Vierzon (200 kiloms., or 124 miles) and Brétigny to Dourdan (27 kiloms., or about 17 miles). The plant consists of twenty-seven 2000-kW sets of exactly similar type. Each set comprises two 1000-kW 750-volt rotary converters connected in series.

The table below gives particulars for each sub-station of the capacity of plant installed and available at peak load. In the Aubrais sub-station there are three 90,000/5500-volt static transformers feeding the rotary converters for the traction supply, each of which is rated at 2000 kW, and has a maximum output of 6000 kW, and three 90,000/30,000-volt transformers for supplying the power and lighting requirements of the district.

Table I.

Sub-stations.	Supply voltage. kV.	Number of sets proposed.	Number of sets installed.	Present power available. kW.
Paris	13·5	4	3	12,000
Ablon	13·5	4	3	12,000
Saint-Michel	90	4	3	12,000
Etréchy	90	4	3	12,000
Monnerville	90	3	2	6,000
Château-Gaillard	90	3	2	6,000
Les Aubrais	90	4	3	12,000
La Ferté	90	3	2	6,000
Nouan	90	3	2	6,000
Theillay	90	3	2	6,000
Saint-Chéron	90	3	2	6,000
Totals	—	34 (*sic*)	27	96,000 (*sic*)

Contact Conductor.—Direct current at 1500 volts is distributed along the track by means of compound catenary lines having a double contact wire. The poles are placed on alternate sides of the track, and are spaced 64 m. (210ft.) apart.

The main supporting cable is of phosphor bronze of 116 square millimetres section. The other cables are of electrolytic copper of the following cross sections—auxiliary carrier 104 square millimetres, contact wires 107 square millimetres.

On the suburban section from Orsay to Brétigny a third rail,[3] used also as a feeder, is provided, in addition to the overhead line. Beyond Brétigny the carrying capacity of the catenary line is increased by means of a copper feeder of 240 square millimetres section.

Rolling Stock.

The suburban trains consist of motor coaches and trailers, whilst the main line trains, both passenger and goods, are made up of the ordinary rolling stock hauled by electric locomotives.

Motor Coaches.—Each motor coach multiple-unit train consists of one, two or three power units, each unit comprising an electric motor coach weighing 65 tonnes and two bogie type trailers, each weighing 34 tonnes, the total weight of the train therefore being 133 tonnes. Each motor coach is fitted with two articulated bogies, and each bogie carries two 250 horse-power, 750-volt motors, which are permanently connected in series.

An order has been placed for eighty motor coaches, from which twenty-five multiple-unit trains of three units each will be formed for the suburban service. At present, eight motor coaches are in service, some at 1500 volts and others temporarily at 600 volts on the old electric traction system.

Locomotives.—Goods and passenger trains rated for speeds lower than 75 kiloms. per hour are hauled by double locomotives comprising two units. Each unit, or half-locomotive, is supported on two bogies, and each bogie carries two 1500-volt motors with forced ventilation. Each motor has, depending on the type, a one-hour rating of from 375 to 430 horse-power, and a continuous rating of from 300 to 375 horse-power.

Two hundred half-locomotives have been ordered, and more than fifty of these have been delivered and are under test or in operation on the electrified lines.

Express trains, having a nominal speed higher than 65 kiloms. or 70 kiloms. per hour, are hauled by special locomotives of slightly greater power than the double goods locomotives, but of lighter construction and specially designed for attaining high speeds.

Five experimental locomotives have been ordered, three of which have been delivered and are under test and adjustment. One is a gearless locomotive of the type "2 C + C 2," having a one-hour rating of 2700 horse-power and capable of developing 2100 horse-power continuously. Two of the locomotives are of the type "2 D 2" with connecting-rod drive, and have a one-hour rating of 4000 horse-power and a continuous rating of 3500 horse-power. One of these is fitted with "hyperstatic" connecting-rods and motors of the usual type, whilst the other has "isostatic" connecting-rods, flexible couplings and fully compensated motors. The other two locomotives are of the type "2 D 2," with outside gear drive and small connecting-rods, and have a one-hour rating of 3600 horse-power and a continuous rating of 3000 horse-power. One of these locomotives is provided with standard running gear and motors and the other with adjustable articulated running gear and fully compensated motors arranged for regeneration.

INTERNATIONAL IRON AND STEEL AGREEMENTS.

In a recent issue the Berlin newspaper *Tägliche Rundschau* gave the following *résumé* of the position of the negotiations for international agreements in the iron and steel industry :—

(*a*) The negotiations for an international rail union have led to an agreement in principle, especially as regards quotas, but a definite and formal conclusion has not yet been reached, although it is hoped that that will be possible in the course of April. Our Paris correspondent deals with this matter in his letter this week—see page 427.

(*b*) On the international wire market an agreement was reached some time ago aiming chiefly at a mutual defence of prices.

(*c*) The discussions regarding an international tube union have led in principle to a far-reaching agreement, and it only remains to do away with a few difficulties.

(*d*) The negotiations for an international raw steel union are only in their initial stages. The basis for these negotiations is a German proposal, according to which each country joining the union would pay into a common fund a certain sum for each ton of raw steel produced. These sums would be credited to the producing country. For every country a figure would be fixed for the production of raw steel. At stated times the relation of actual production to this figure would be calculated. The countries which had overstepped the limit would be debited with a certain amount for every ton in excess and the same amount would be credited to the countries which had not reached their limit. Accounts would be settled yearly. On this proposal preliminary and non-binding conversations have already taken place with France, Belgium, and Luxemburg, and the proposal has been communicated to Poland, Austria, Czechoslovakia and Great Britain, but negotiations with those countries have not yet been opened.

It seems clear that no revival of the well-known Luxemburg agreement, especially as regards indemnities to the Lorraine iron producers, will be discussed and that the quantities of foreign iron entering Germany in the future will still be distributed to the consumers through the German unions in order to avoid the disturbance of the German market, which would happen if foreign material were placed pell-mell on the market. According to the *Tägliche Rundschau's* information, a guarantee by Germany to take fixed quantities from France and Luxemburg is also under consideration.

The German Government, which from the beginning has been kept well informed of all these negotiations, is said to look on them with a favourable eye, and the iron users, who have also been informed, regard, as particularly important, the fact that the aim of the negotiations is not a rise in prices on the inland market but on the foreign market.

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* From a paper by H. Parodi, read by Mr. Roger Smith at a meeting of the Institution of Electrical Engineers.

[1] Metric ton (1000 kilos.).

[2] The power indicated in brackets is the capacity of the plant installed.

[3] Experience has shown that this third rail allows current to be collected with certainty, even in the winter. Owing to two neighbouring tracks being provided with third rails having the ordinary type of surface contact, it has been possible to make definite comparisons, with the above-mentioned result.

The Second Narrows Bridge, Vancouver.

WHAT is known as the Second Narrows Bridge, which spans Burrard Inlet at Vancouver, British Columbia, was formally opened on November 7th, 1925. The proposal to construct a bridge to give direct connection between the north and south shores of Burrard Inlet was first discussed as far back as some forty years ago, but for various reasons, into which we need not enter here, it was not until July, 1923, that a contract was entered into between a company specially formed to bring about the erection of the structure, of the one part, and the Northern Construction Company, Ltd., and a Mr. J. W. Stewart, of the other part, for the building of the bridge, which is described below.

A birdseye view of Burrard Inlet and its vicinity is given in Fig. 1. The Inlet itself constitutes the second largest natural harbour of the world, and is certainly among the most perfect, owing to its land-locked and sheltered position. It extends for some 18 miles from the North Arm, which reaches up to Indian River Park, to the First Narrows, where it joins the Gulf of Georgia on the Pacific Ocean. On the south of the inlet is the city of Vancouver, which has for many years now been gaining in importance, and, near by it, is New Westminster. On the North Shore are the city of North Vancouver and the township of West Vancouver. To the eastward of these two places there are extensive stretches of water front which are ripe for the development that will undoubtedly take place now that there is physical connection by means of the railway with the main transcontinental lines of Canada and the United States. The North Shore has always been regarded as a district of great potentiality, particularly in connection with its residential, industrial and scenic attractions. The entire section is bounded on three sides, east, south and west, by deep water, and it has over 40 miles of continuous shore line. The impetus given to progress by the construction of the bridge has already made itself apparent in the direction of the construction of new roadways both by North and West Vancouver, and the formation of a new marine drive by the latter. Railway lines from the bridge now extend to Lynn Creek, but will, in the near future, connect with the Pacific Great Eastern, which operates between North Vancouver and Horseshoe Bay on Howe Sound.

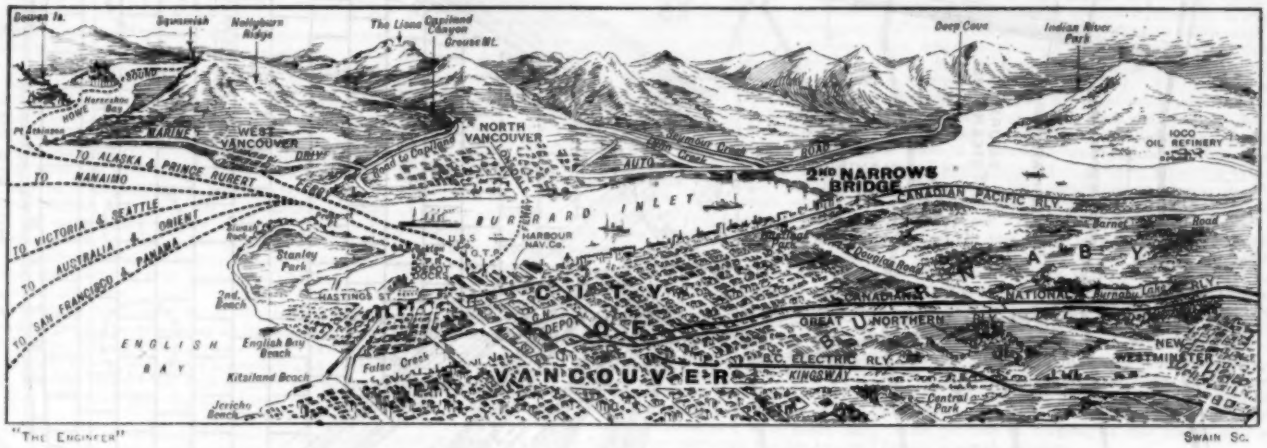


FIG. 1—BIRDSEYE VIEW OF VANCOUVER AND DISTRICT SHOWING POSITION OF SECOND NARROWS BRIDGE

The structure was designed by Mr. Wm. Smail, the Chief Engineer of the Northern Construction Company, and its erection was supervised by him on behalf of the contractors. It was originally intended, since it was necessary for shipping to pass up beyond the bridge, to have a swinging span, but after the contract was let it was decided, on the representation of the Provincial Government, to have a lifting span instead. Similarly, the loading capacity of the vehicle roadway was changed from a 10-ton to a 15-ton gross loading, to conform with the road standard adopted by the Provincial Government. Furthermore, the structure and approaches were raised 5ft. and two 150ft. spans were added on the north side. The cost of these alterations were, in each instance, defrayed by the Government authority requiring them.

The bridge was designed of standard railway construction, known as "Cooper's E 50 Loading" plus 100 lb. per square foot for rpadway allowance—subsequently, as explained above, increased to 15-ton truck gross loading. The total length of the bridge and approaches—which extend from Cariboo St. on the South Shore to a point D.L. 272 immediately west of Lynn Creek in the city of North Vancouver—is about 1¼ miles. The structure comprises one fixed span of 300ft., three fixed spans of 150ft., and a bascule lifting span of 185ft. in length, with 650ft. of trestle work at the south end and 850ft. of trestle work at the north end, and about 4500ft. of railway embankment at the north end. There are, in addition, a 60ft. pony truss bridge over the Canadian Pacific Railway on the south side and a 150ft. steel span over the Lynn Creek on the north side. The bridge is of the single-deck type, having a line of railway in its centre, with a 10ft. roadway on each side of it and a passenger footway beside the east roadway.

There are six piers, four of them being cylinder piers. For three of them, which were sunk in deep water, compressed air had to be resorted to. The longest pier is No. 2, which measures about 120ft. over all in length. It stands in about 85ft. of water, and it is sunk to a depth of some 21ft. below the bed of the inlet. The total depth below the surface of the water is therefore about 106ft., which is believed to be the greatest depth to which a compressed air caisson has ever been sunk in tidal waters. It is stated that, at the time of the construction of the piers, the tidal flow was about 7 miles per hour. There is a clearance of 22.2ft. between high water level and the lowest chord of the bridge.

The operation of the bascule span is effected by means of two 100 horse-power motors, one of which is kept in reserve. There is also a 75 horse-power engine for use in case of emergency. The counterbalance, which is of concrete, weighs 1000 tons. For safety control, the bridge is equipped with traffic gates, each of which is operated independently, so that oncoming traffic can be stopped without preventing traffic already on the bridge from proceeding across. These traffic gates are interlocked with the bascule, so that it is impossible to open the latter until the former are closed. Signalling is effected by daylight signal lamps, which have a colour visibility of from 3 to 4 miles in broad daylight.

FIG. 2—THE SECOND NARROWS BRIDGE

The approximate cost of the bridge is given as being 1,800,000 dollars, or, say, £360,000. It was financed by the purchase of shares and the guarantee of debentures of the bridge company. The shareholders are:—The District and City of North Vancouver, the City of Vancouver, and the District of West Vancouver. In addition, grants were received from the Dominion and Provincial Governments. The construction was carried out with Mr. A. D. Swann, M. Inst. C.E., as consulting engineer, and with Mr. E. H. James, Assoc. M. Inst. C.E., as resident engineer.

We are indebted for the particulars contained in the foregoing to a brochure which was specially prepared for the official opening of the bridge, the ceremony of which was performed jointly by the Hon. Dr. J. K. King, Minister of Public Works, his Honour Lieut.-Governor W. C. Nichol, and the Hon. John Oliver, the Prime Minister of British Columbia.

SIXTY YEARS AGO.

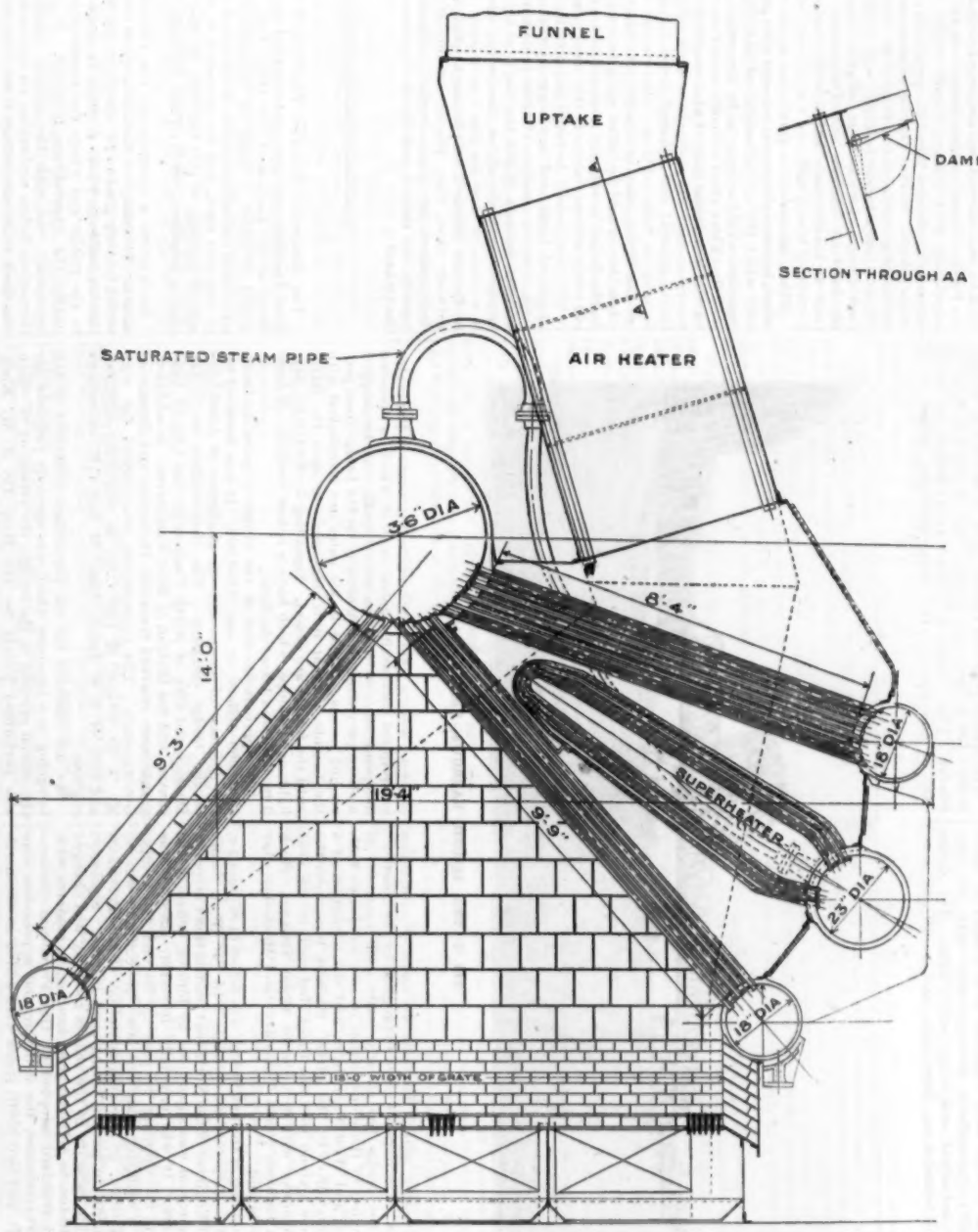
DAVID ELDER, the celebrated Scottish marine engineer and shipbuilder, died on February 7th, 1866, in his eighty-second year. In our issue of April 6th of that year, we reprinted an address summarising the principal incidents and achievements of his life which Mr. James R. Napier had read before the Institution of Engineers in Scotland. The memoir bears signs of having been hurriedly prepared—it was presented just seven days after Elder died—but even so it reveals in its subject the possession of those instinctive faculties and hard-headed originality which we rightly associate with the great pioneers of our profession. Elder was born near Kinross in 1785. His father, a country wright and an anti-burgher elder, played a part in the religious strife of the district, which led to his son being deprived of such education as the local parish school afforded. At fifteen the future engineer was learning his father's business, and was soon employed on repairs at the neighbouring mills. Determined to educate himself, he travelled 18 miles to obtain a translation of a French work on algebra, and when his seniors were devoutly employed at a "tent preaching," he was to be found studying hydraulics before some old water-wheel. In 1804 he went to Edinburgh, and while carrying on his trade continued his studies by means of books borrowed from a stall in the Luckenbooths at a penny a night. By 1814 he was married and employed with J. Clark and Co., the Paisley thread manufacturers. In 1821 he formed that association with Robert Napier which for many years afterwards afforded him full opportunity for the exercise of his talents. In that year he became manager of Napier's engineering works, then situated at Camlachie, Glasgow. About a year afterwards Napier contracted to build his first marine engine for a steamer called the Leven, which was to ply between Glasgow and Dumbarton. With the few tools at his disposal—lathes with wooden shears, a rude horizontal boring mill, and a small vertical boring machine—Elder succeeded in producing a set of machinery to which he often afterwards referred with pride. The respect with which the old millwrights of those days are now often regarded would appear to be somewhat misplaced. We read that Elder's first difficulty arose from the difference between his and their ideas of what constituted good, accurate workmanship. He preferred to work with cartwrights and house joiners, and selected them for important posts, because he believed that "they would carry their ideas of close-fitting joints of wooden structures along with them when they would be called upon to construct iron ones." In this belief he was not disappointed. Besides introducing many improvements in the marine engine, of which it is here unnecessary to recall the details, he devised many improved tools and workshop appliances. One of his tools, a paring machine, the first of its kind, caused trouble in 1833, because it did the work of the "legal hands," as those workmen called themselves who had combined in a union to stop the firm's activities. Elder continued in Robert Napier's employment until about 1853, and between them they played an important part in the development of many leading steamship companies, notably the British and North American Company, now the Cunard.

THE BESSEMER MEDAL.—The Council of the Iron and Steel Institute has this year awarded the Bessemer Gold Medal of the Institute to Sir Hugh Bell. The medal, the award of which is made in recognition of outstanding services in the advancement of the art of the manufacture of iron and steel, will be presented to Sir Hugh at the annual meeting of the Institute on May 6th by the incoming president, Sir W. Peter Rylands.

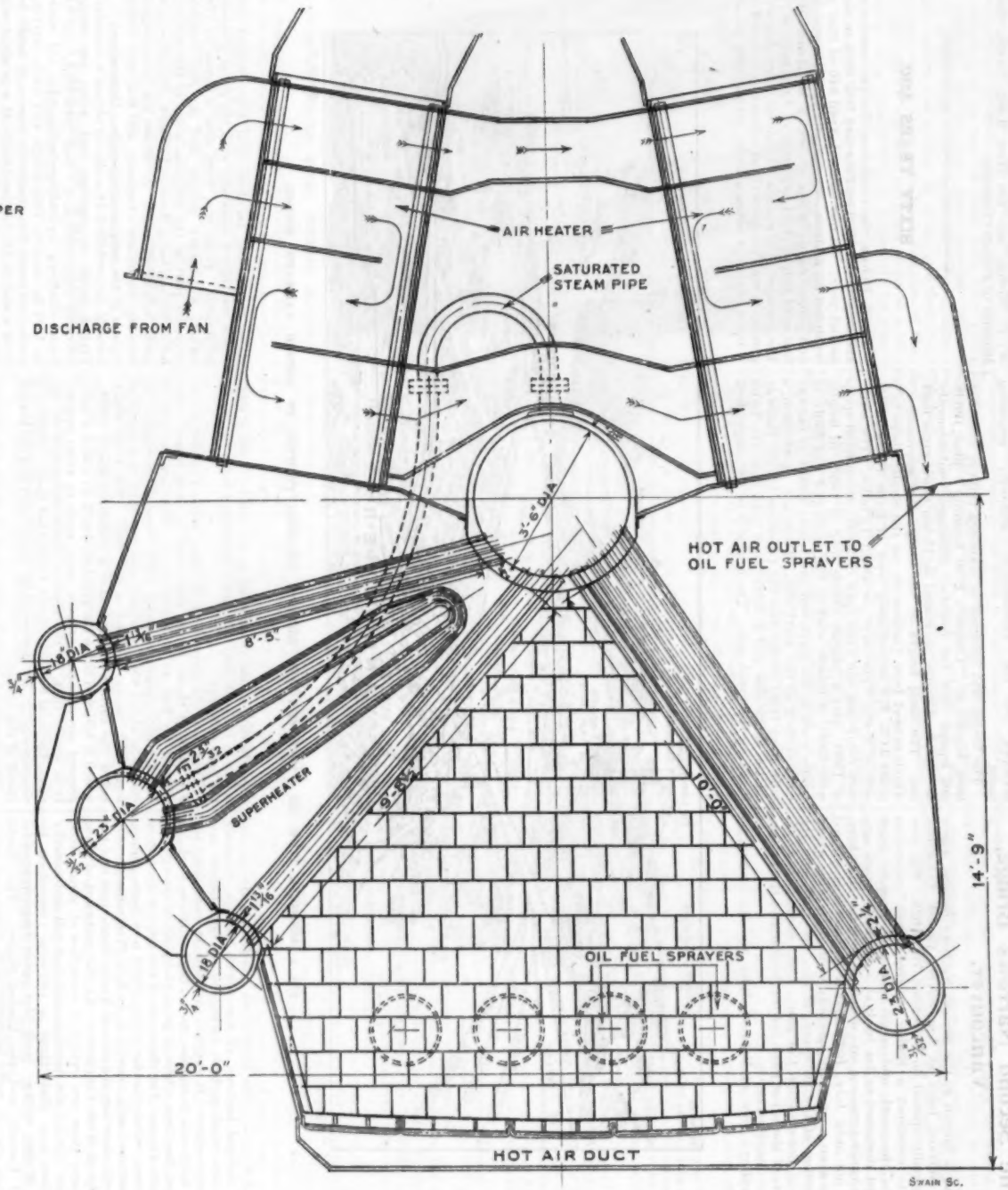
ANSWERING a question on the 16th ult., the Parliamentary Secretary to the Ministry of Transport said he would be very glad to see an extension of electrical traction on railways where it could be done with advantage to the public and where the results would be likely to justify the expenditure involved. It must, however, necessarily rest with the railway companies to satisfy themselves before embarking on any such scheme that it was likely to be satisfactory from every point of view.

HIGH-PRESSURE WATER-TUBE MARINE BOILERS

YARROW AND CO., LTD., SCOTSTOUN, ENGINEERS



575 LB. PRESSURE SINGLE-FLOW BOILER FOR CLYDE STEAMER



PROPOSED 1000 LB. PRESSURE DOUBLE-FLOW BOILER

High-pressure Water-tube Boilers for Marine Purposes*.

By HAROLD E. YARROW, C.B.E., Member of Council.

IN submitting the present paper to the Institution, an endeavour has been made to investigate the practical application of high pressures and temperatures on board ship, and to make special reference to a definite step which has been taken in introducing high-pressure boilers in a passenger steamer at present under construction.

The adoption of high pressures and temperatures on land has already made considerable progress, and just in the same way as the introduction of the steam turbine for marine purposes followed some years after its introduction on land, so it would appear that history is repeating itself in the case of high-pressure boilers. Boiler installations having steam pressures of 500 lb. to 600 lb. per square inch, and superheat temperatures of 700 deg. to 750 deg. Fah., are in commercial use in a number of power stations, and such pressures and temperatures may be said to have passed the experimental stage.

If therefore these pressures and temperatures can be adopted on land, there seems no reason why they should not likewise be adopted at sea. There are certain fundamental factors common to both, among them suitable materials and workmanship. The better and more uniform materials now in use, and the improved metallurgical and manufacturing methods now adopted, remove from the designer's mind any anxiety as to materials. Copper, wrought iron and cast iron have been discarded in the manufacture of water-tube boilers of high pressures. Steel is in common use, and its uniformity leaves little to be desired. Certain of the non-ferrous alloys which are now used also contribute to that security which characterises modern installations.

Workmanship must obviously be of the very highest class throughout, just in the same way as the manufacture of the Diesel engine requires the greatest skill. It may therefore be accepted that, with good materials and workmanship, no trouble should be experienced in boilers working at the pressures and temperatures mentioned above.

There is, however, one difference between land and marine practice, namely, that in the latter case there is always the risk of a leaky condenser allowing salt to enter the system, although it must be remembered that there are many electric power stations where the condensing water is by no means entirely free from salt.

The presence of salt can be detected immediately by various means, and in the Navy from the time a leaky condenser tube is discovered to the time when this tube has been plugged and the installation is again under way occupies only a very short period. Sir Charles Parsons has proposed to subdivide the condensers, so that one of them can be isolated if a leak is discovered. Both these methods are merely remedial, but with the investigations now being carried out, such, for instance, as adopting different materials for condenser tubes, it may be assumed that this trouble will be finally overcome. It is hardly conceivable that, with the skill of the engineer and metallurgist, progress along any promising line of development will be retarded because no means can be found of keeping salt out of the feed system.

Fear has been expressed that with high temperatures and increased pressures there will be a difficulty in keeping steam joints tight, and that this will be more serious on board a vessel than in a power station, as the latter generally consists of a large open building and all joints are easily accessible. There does not seem to be any valid reason to fear this difficulty, for if proper materials and high-class workmanship are employed, steam joints can be made quite satisfactory. A suitably designed metal-to-metal joint with strong bolts and thick flanges should give no trouble. In one respect, the problem is simplified in a marine installation as compared to land boilers, because in the latter case the units are usually much larger and the valves and pipes are, in consequence, very much bigger than on board ship. For instance, the steam pipe from each of the Yarrow boilers at the County of London Electric Supply Company's station at Barking, working at 400 lb. per square inch and 725 deg. Fah. superheat, has a diameter of 8in. and joins up to the 12in. main steam pipe line. In a steamship of 24,000 shaft horse-power, having six boilers of 575 lb. pressure and 750 deg. Fah. superheat, the diameter of the main steam pipe from each of the boilers would be only 4in., and would connect into two 7in. steam pipes in the engine-room. The valves and boiler fittings would be of smaller size and their design therefore simplified.

In considering the problem of turbine installations with high-pressure boilers, it may be assumed that a boiler efficiency of not less than 85 per cent. will be realised when air heaters are fitted, and in the case of boilers with straight and well inclined tubes, the rapid circulation of the water keeps the tubes clean, and therefore a high efficiency can be maintained over long periods of service.

It may be of interest to the meeting to give some particulars of two high-pressure boilers, coal fired, which will be installed on a passenger vessel now being built by Messrs. William Denny and Brothers for Turbine Steamers, Ltd., the managing owners of which are Messrs. John Williamson and Co.

In determining the type of boiler for this vessel, it was necessary to select a design that would be suitable for general mercantile practice, and one preferably free from as many bolted and riveted joints as possible, due to the high pressure to be adopted. It was also considered important that all the pressure parts should be as far as possible circular in section. After careful investigation it was decided to adopt the Yarrow type, and the order was placed for the two boilers by the main contractors, the Parsons Marine Steam Turbine Company, with Yarrow and Co., Ltd.

The design of the boiler has been passed by the Board of Trade, whose officers have offered many valuable suggestions, and who have given every assistance to facilitate this new development. Each boiler—a general arrangement of which is shown in the left-hand drawing on page 410—has a total heating surface of 3420 square feet, of which the superheating surface is 870 square feet; in addition, there are 2200 square feet of air heating surface for preheating the air prior to its admission to the closed ashpit. The safety valves are set to 575 lb. pressure, and the final temperature will be from 700 deg. to 750 deg. Fah. The test pressure is 913 lb. The design generally, while not unlike that used in the Navy, has been based on mercantile practice, and more closely follows the design of the Yarrow land type boiler now in use at several electric power stations.

As will be seen from the left-hand drawing on the opposite page and the half-tone engravings on page 414, the boiler consists of a forged steam drum connected to the three forged water drums by means of straight tubes expanded and bell-mouthed in accordance with the usual practice. Between the two water drums on the right-hand side of the boiler is a superheater, which consists of a forged drum with a number of U tubes, and which is placed between the two generating elements. The gases all pass up one side of the boiler and through the air heater situated above the boiler and to the funnel. The reason for adopting a single-flow type of boiler where all the gases pass through one side is because this design makes in this particular case a somewhat better arrangement in the ship than the double-flow type, where the gases pass equally through each side. The generating element on the left-hand side of the boiler absorbs a considerable portion of the heat from the furnace by direct radiation, and it will be noted that the proportion of the total surface of the boiler subject to direct radiation is considerable, which is an important feature in modern water-tube boiler design, not only increasing the output and efficiency of the unit, but also providing a large amount of comparatively cool surface adjacent to the combustion chamber, which lengthens the life of the brickwork.

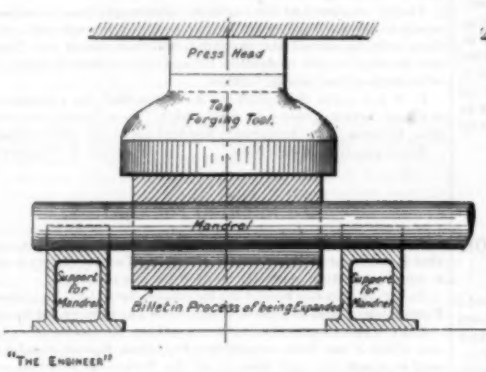


FIG. 1—EXPANDING

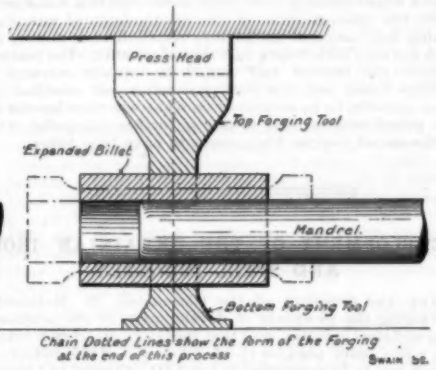

Press Head
Top Forging Tool
Expanded Billet
Mandrel
Bottom Forging Tool
Chain Dotted Lines show the form of the Forging at the end of this process
SWAIN DS.

FIG. 2—FORGING

The admission of air for combustion is arranged in the following way:—The cool air in the stokehold enters an opening between the inner and outer casings at the front of the boiler, about 6ft. up from the firing floor, passes up the double casing through the air heater, down the double casing at the back of the boiler into the closed ashpit, and so through the fire-bars. The efficiency of the unit is naturally increased by the air heater, which extracts heat from the flue gases, and, in addition, the air in its passage to the combustion chamber, as above described, takes up a certain amount of heat which would otherwise be lost due to radiation, and incidentally keeps the stokehold cool. Also the circulation of air in close proximity to the furnace lining helps to keep the brickwork at a temperature which ensures low cost of upkeep.

For controlling the supply of steam—especially as, unlike an oil-burning boiler, the supply of fuel cannot be quickly cut off—various means of regulation have been provided. If reference is made to the left-hand drawing on page 410, it will be seen that a damper is fitted in the uptake at the side of the top of the air heater. When this damper is in its horizontal position the air passes through the air heater to the combustion chamber. When, however, the damper is brought to a vertical position, the air from the fan passes straight up to the funnel, thereby short circuiting the air heater and entirely stopping the supply of air for combustion. This arrangement would be used when the engines are stopped suddenly, *e.g.*, when the vessel stops at a pier. Provision is also made for controlling the speed of the forced draught fan, thereby limiting the amount of air for combustion. A still further control is to by-pass the steam direct from the boiler to the condenser by the silent blow-off.

In preparing the design of a high-pressure boiler, it is advisable to reduce the number of riveted and bolted joints to a minimum, and how this has been accomplished in the present case will be seen from the fact that the steam drum has no riveted joints at all, and, apart from the attachment of boiler mountings, the only bolts are those required to secure the two internal manhole doors. In the water drums and superheater drum there are no longitudinal joints, and only one circumferential riveted joint securing the front end plate in which the manhole is placed. The other end of these drums is solid.

All the drums have been manufactured by John Brown and Co., Ltd., of Sheffield, and a short description of the process of manufacture may be of interest. The steel used is ordinary boiler steel, 26–30 tons, with 30 per cent. elongation in 3in. lengthwise, and not less than 20 per cent. elongation in 3in. transverse. The large steam drum is made by the following method:—A large octagonal ingot is forged under a hydraulic forging press to a round billet; it is then cut to a length which will give the weight necessary for the finished forging, and is carefully examined for any surface defects. The billet is then bored with a hole throughout its entire length, large enough to take a mandrel for the second forging operation.

The second forging operation consists in expanding the billet to a larger diameter without increasing the length; the internal diameter after this operation is slightly less than the finished diameter of the steam drum. This operation is shown in Fig. 1. The expanded forging is reheated ready for the third operation, which consists in forging on a mandrel in such a manner as to increase the length without increasing the diameter. A large mandrel is used of a diameter approximately that of the finished drum, and forging is continued until the required length is obtained. This operation is shown in Fig. 2. The chain-dotted line shows the form of the forging at the end of the process. The thickness of the main body is now that required for the drum, plus machining allowances.

The ends of the forging are left thicker to allow for the final operation, which takes place after the internal diameter of the drum is bored to the finished sizes. This last forging process consists in closing in both ends as nearly as possible to the required shape of the finished drum. The final closing-in is performed on a round bar or mandrel somewhat smaller in diameter than the manholes in the ends. The forging is then thoroughly annealed and sent to the machine shops, where the necessary mechanical tests are taken and the final machining carried out.

The process of forging of the water and superheater drums is much simpler.

The boiler tubes and superheater tubes are solid drawn cold finished. The problem of boiler fittings, such as safety valves, stop valves, joints, &c., is one to which much care must be devoted. The safety valves require special consideration in design and construction for high pressure and temperatures. The ordinary safety valve, with its small lift, is a trap for grit, &c., when the valve is blowing off. The valve shuts down on this grit and soon indentations grooves to be cut. The safety valves for the two boilers above referred to are of the high-lift type manufactured by Cockburns, Ltd., and either this type or the full-bore safety valve manufactured by the same firm would seem to meet adequately the problem of high pressures and temperatures. The stop valves and other fittings are of the usual design, strongly constructed and of suitable materials. The main stop valve has monel metal spindles, valves and seats, but other materials have been found to be equally satisfactory. The joints, as already stated, are metal to metal, and the flanges are particularly thick, so as to avoid the possibility of any distortion. The feed regulators are being supplied by the Aster Engineering Company, Ltd., and the water gauges by Dewrance and Co., Ltd.

With regard to the initial cost of a high-pressure boiler, the price of the solid drums is at present greater than built-up drums, but a number of the fittings are common to boilers, whether for high or low pressure, such as furnace fittings, casings, uptakes, air heaters, brickwork, &c., so that the total increase in cost is not considerable.

It is estimated that the two boilers described above with forged drums for 575 lb. pressure cost approximately 15 to 20 per cent. more than similar boilers having the same total heating surface, but having a boiler pressure of 250 lb. pre square inch. If, however, a comparison is made on a more correct basis—that is to say, taking into account the fact that the quality of the steam from the 575 lb. boiler is of a higher value than in the case of a lower pressure—then the cost of the high-pressure boiler is very little more than the cost of the other. The saving due to the reduced heating surface required in the case of the high-pressure boiler nearly compensates for the additional cost of the forged drums and certain other rather more expensive fittings. The initial cost of high-pressure boilers is therefore no handicap to their introduction.

The right-hand drawing on the opposite page shows a Yarrow boiler suitable for 1000 lb. pressure, the boiler being of such a size as would produce steam for 4000 shaft horse-power when being worked at a very moderate rating. This boiler is of the double-flow type, but it can, of course, be designed for single flow, depending upon the general lay-out of the boiler-room.

* Institution of Naval Architects. Slightly abridged.

Books of Reference.

Hütte des Ingenieurs Taschenbuch. Vol. I. 1926. Wilhelm Ernst and Sohn, Wilhelmstrasse 90, Berlin, W. 66. Price 13.20 R. Marks.—The Jubilee edition of this old established German engineers' pocket-book coincides curiously with the seventy-fifth anniversary of its publishers, Wilhelm Ernst and Sohn. The first edition of Hütte was issued in 1857, and the remaining twenty-four issues have appeared at intervals of from two to three years. The complete pocket-book for 1926 will comprise four volumes, the first of which is to hand. It deals mainly with mathematics, mechanics, technical physics, heat, and the strength and properties of materials, together with the source of measurement and also surveying. In the second volume prime movers and machine tools will be dealt with, whilst the third volume will be devoted to civil engineering and building construction, and the fourth to transport, mining, and the technics of various industries. Volume I., which lies before us, is a book of over 1040

pages, excluding a very complete index. Several chapters have been re-written and extended, and new matter has been introduced.

Hütte Taschenbuch der Stoffkunde, 1926. Wilhelm Ernst and Sohn, Wilhelmstrasse 90, Berlin, W. 66. Price 22.80 R. Marks.—This volume, which is published in a form similar to the familiar Hütte pocket-book, deals entirely with constructional materials and industrial substances and their properties. After a short introductory chapter on chemistry, there follows a long section on the testing of materials, which embraces the metallographical, physical, chemical, magnetic and electrical methods of testing. Metals are then dealt with under the headings of iron and steel, non-ferrous metals, while non-metallic inorganic substances, reagents, glass ceramics and grinding and polishing materials are also included in this section. Substances of vegetable and animal origin, such as textile fibres, wood, paper, cellulose, leather and various by-products are included in the fourth section of the book, which includes fuels, tars, tar products, oils, and explosive materials. The text contains numerous illustrations, and covers some 1150 pages. An index of subjects and names is also appended.

"Chemical Engineering and Chemical Catalogue: A Work of Technical Reference for all Production Industries," Second edition, which is obtainable from Leonard Hill, 173, Fleet-street, London, E.C. 4, price 15s., though technically, perhaps, a catalogue, is actually a good deal more; it is a well arranged directory and a useful book of reference which tells the would-be buyer from what firm or firms he can obtain that which he requires, provided, of course, that it be within the area of the products which it covers. We cannot, we think, do better in explaining its scope to our readers than by quoting from a foreword by Sir Robert Hadfield, which appears on its opening page. Sir Robert says:—"Its very clear arrangement, enabling the buyer to find easily and quickly the names and particulars of British manufacturers of chemical products, and in a mannner separated from the distractions of advertising display should, I believe, appeal to many. The comprehensive nature of this catalogue in combining the chemical trades with those of the many associated industries should also prove of advantage to the busy man. In particular, it should assist especially our Overseas customers, providing a means to enable them with the least possible effort to follow up, by practical inquiries and orders, the good impressions they must have formed as the result of the British Empire Exhibition of the high quality of British chemical products.

"The Directory of Paper Makers of the United Kingdom," which is published by Marchant, Singer and Co., of 47, St. Mary Axe, London, E.C. 3, price 5s. net, appears this year in its fiftieth annual edition. It contains, as usual, alphabetical lists of paper makers, paper enamellers, gummers, &c.; paper makers' representatives in London and the provinces and the mills represented; London wholesale stationers; mills with the names of their occupiers; and mills arranged in counties, with maps. It also contains a classification of makes with the makers' names, lists of trade designations used by paper makers, wholesale stationers, &c., embodying actual watermarks, and named papers, &c., not bearing actual water marks. In addition, there are particulars concerning trade customs, lists of sizes of paper, &c.

"Specification." For Architects, Surveyors, Civil Engineers, and for all interested in Building, appears in the 1926 edition in its twenty-eighth yearly issue. It is edited by Mr. Frederick Chatterton, F.R.I.B.A., and is published by the Architectural Press, 9, Queen Anne's Gate, Westminster, S.W. 1, price 10s. 6d. net. In this year's volume a change has been made in the sequence of the standard specification clauses, which form a leading feature of its contents, by which their order has been brought more strictly into accord with the arrangement most generally adopted by architects when drafting their specifications. Another improvement in the present edition is that the data relating to ordinary "mass" concrete have been separated from that which deals with reinforced concrete, and each branch of the subject has been confined to a distinct section. An entirely new article on "Shuttering" has also been included. There is also a double-plate in colour displaying the characteristic figure and grain of sixteen selected joinery timbers. Finally there are five special articles, all contributed by experts on: "Musical Pavilions," "Cast Stone," "The Law of Ancient Lights and its Suggested Amendment," "Empire Timbers," and "Rapid Hardening Cements."

Gas Oil for Petrol Engines.

In view of the recent letters in our correspondence columns on the use of heavier fuel oils in petrol-paraffin engines, it was with considerable interest that we recently inspected at the works of the Parsons Motor Company, Ltd., of Southampton, one of the firm's standard engines which has been designed to run on gas oil.

The engine we saw on test was a four-cylinder model with 6¼in. bore cylinders and 8in. piston stroke. It was designed to run at a speed of 750 revolutions per minute and to give an output of 65 brake horse-power on petrol and 55 on paraffin, 45 brake horse-power is developed when running on gas oil. For the use of gas oil we were informed that no major alterations to the engine have been made other than the fitting of a specially designed vaporiser. The new design of vaporiser is the result of extended experimental work, and we are given to understand that ultimate success was achieved by careful attention to the arrangement of the gas passages and their heating, while the timing of the valve system and the shape of the combustion chamber in the standard engine have also materially assisted in obtaining good running results. We need hardly describe in detail the various features of the new Parsons design, which formed the subject of an article in our issue of July 17th, last. We may remark, however, that the engine is closely governed and is fitted with a hand lever and separate throttle for speeds below the governed speed. The engine bed-plate is water cooled and a forced lubrication system is fitted to all bearings.

During the test we witnessed the engine was started from cold and run up on petrol to its normal speed, the load being taken on a Froude water brake. There was no visible exhaust when the engine was on load. After about seven minutes' running—in order to heat up the water-cooled vaporiser—the petrol was turned off and gas oil of a specific gravity of 0·85 to 0·86, 180 deg. Fah. flash point, and a calorific value of 19,800 B.Th.U. per pound, was admitted into the fuel system. The change of fuel was scarcely noticeable in the behaviour of the engine and the exhaust continued colourless with a very occasional tinge of grey haze throughout the full-load trial. After about three-quarters of an hour's run we saw the engine throttled down and run for some time at slow speed while still on gas oil. The throttle was opened out after the low-power trial and the engine again took up her load without incident, the exhaust being slightly darker until full-load running conditions were again established. Throughout the trial the engine seemed to maintain its wide range of flexibility.

The makers inform us that the engine will run at its rated load of 45 brake horse-power over long periods and that no trouble is experienced with carbonisation either with the vaporiser passages or the ignition plugs. During the experimental work a special form of plug was employed with a sliding centre electrode, which could be moved while the engine was running. Experience has since shown, however, that special plugs are not really necessary. Although provision was made for removing any heavy oil residue from the vaporiser, it has been found that the inlet system, the combustion chambers and the vaporiser passages themselves remain remarkably clean. It is recommended by the builders that after working on gas oil a run should finish on petrol, which undoubtedly assists in the cleaning out of the fuel system and the cylinders, and, moreover, leaves the engine in good condition for starting up.

From the inquiries which the firm has received there is evidently, we learn, a wide field for the petrol-paraffin type of engine designed to use heavier fuel oils. The Parsons Motor Company, Ltd., is now engaged in producing its smaller engines with special vaporisers to enable it to make use of gas oil fuel. Such engines should be particularly useful for portable and stationary plants where running costs must be reduced to a minimum. With the present price of gas oil the cost of running, taking into account the slightly reduced horse-power, is, with gas oil a little over a half that of paraffin. For marine engines the heavier fuel should be equally attractive. Twenty years ago the Parsons engine was modified to allow paraffin to be employed on what was then known as the petrol engine, and to-day a further successful step in the use of heavier fuels seems to have been taken.

DEVELOPMENT OF THE UKRAINIAN IRON AND STEEL INDUSTRY.

The vice-president of the Glavmetall, M. Mezhlauk, discussing the prospects of development of the southern iron and steel industry, said that the Glavmetall had worked out a five years' plan for the development of this industry, which was to be submitted to the STO—Council of Labour and Defence. According to the plan the production of pig iron in South Russia would reach 337,000,000 poods—say, 5,400,000 tons—in the year 1929–30. Out of this total only 7,000,000 poods was taken as the share of the new Krivorog works, the rest being produced by works now active. M. Mezhlauk went on to say that in the Ukraine it was intended to build only one new iron and steel works, and for it the Glavmetall had finally chosen a site in the Krivorog district. The proposed output of the new works was 40,000 poods of pig iron a year. Construction would begin next year.

Speaking on the question of the parts of the Union in which the development of the iron and steel industry would proceed during the next few years and referring to a certain feeling of neglect in the Ukraine as regards the building of new works, the vice-president said that it was proposed to spend on the Union's metal industry during the next five years, including this year, a sum of 609,700,000 roubles, out of which 465,000,000 would fall to the share of the Ukraine and only 125,300,000 to the Urals. It was hoped to raise the production of the Urals to 81,000,000 poods and the total production in the Union of 440,000,000 poods. The Ukraine would thus take the first place in the development of the iron industry.

As regards the metal working-up industry, M. Mezhlauk remarked that the Government did not intend to build any fresh general engineering works in the Ukraine, but that during the next few years it was proposed to build in the Zaporozhye a plough factory, which was to have a yearly output of 6,275,000 ploughs. Moreover, the building of merchant vessels was to be developed at the Nikolaievski works in the Ukraine, 3,050,000 roubles being spent during the next five years on those works, so that the Ukraine was destined to be the chief theatre of the development of the iron and heavy engineering industries. The Government's plan also provided for an extension of locomotive construction at the Luganski works.

Tumbler Switches.—Two exceptionally well-made tumbler switches have been sent to us for inspection by J. H. Tucker and Co., Ltd., of King's-road, Tyseley, Birmingham. They are rated at 5 and 15 ampères at a pressure of 250 volts, but tests have apparently shown that the switches will deal with considerably higher currents. Tests carried out at Faraday House have demonstrated that the switch rated at 5 ampères will deal with a current of 33 ampères and with its normal rated current at a pressure as high as 525 volts. The make and break on both the switches are very rapid and all the parts are strong and well made. The switches have been put on the market to meet the demand for a circuit making and breaking device that is capable of withstanding a considerable overload.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE LIMITING FACTOR.

Sir,—On reading Mr. Chorlton's recent paper on the high-efficiency oil engine, and also the criticism levelled at it by your correspondent, S. F. C., one is forced to the conclusion that very rapidly and literally the engineer, no matter how able of brain, is being "hoist by his own petard," for he has displaced labour to so vast an extent that labour, enlightened by the partial education of the past thirty years, refuses to build his inventions at a cost that enables their technical advantages to be usefully employed from the accountant's standpoint.

I do not think this contention can be justly refuted and, if it holds true, the position of the engineer in the future is worthy of consideration. To any student of Gibbon the signs of the times are not difficult to read, and no nation that tolerated long-haired men and short-haired women for any length of time, or which looked with complacency on the outward signs of sex inversion and the emancipation of woman has been known to survive. If these be unpopular words they are none the less true. Going downhill as we thus are to-day one sees only one ray of hope ahead, viz., that the distant war mutterings now spreading westward from Pekin and Moscow may become sufficiently pronounced to shake us all together and discount the windy Bolshevism of Mr. Cook and others of his kidney in time. It is in the fervent hope that this may come before it is too late that I refer to what the engineer may do more usefully than to "gild the present lily" of efficency. Surely to *simplify* the essential methods of mechanical transport, agriculture, and manufacture for native handling is to-day indicated as his most useful work. Also to evolve the most efficient weapons of destruction for the extermination of countless hoards of an utterly ruthless enemy. Who with intelligence can doubt the Issue approaching? Yet who amongst our politicians has the courage to speak of another war even as a remote possibility? One need not labour that point, but one cannot help feeling, to return to the subject, that a reversion to coal fuel for many purposes, however retrograde scientifically, would impart just that human touch betwixt thinker and worker that would go far to abolish the class war that progress has done so much to create. Ask the Cunard staff whether her coal or oil-fired Atlantic records count for most in the Mauretania's stokehold: and my meaning will be clear.

To-day so surely as the engineer takes work from mankind so surely he breeds Bolshevism, but up to that point when his inventions help to spread the surplus population about our Empire and develop it, and to destroy the enemies of that Empire, then is his work sound and no further.

Is it not quite clear that we have reached the *ne plus ultra* and had better "retire in good order" to advance once again than to press on to irreparable destruction at our present gait?

Southampton, March 30th. Stanley P. Christie.

ENGINEERING FOUNDATION.

Sir,—Your editorial on "Too Many Institutions" suggests that it might be well to affiliate the many Technical Institutions to an organisation specially created for the purpose.

In U.S.A. this has been done by establishing the "Engineering Foundation," and the status of engineers has been raised thereby.

I think the time is ripe to do something on similar lines here, and when it has been established for Great Britain it might be well to reach out and take in all the Technical Institutions in the Empire.

E. Kilburn Scott.

London, March 30th.

ELECTRICAL EXHIBITION AT OSAKA.

Wonderful progress has been made in Japan of recent years in the application of electricity to all branches of activity. As recently as 1918 the first Electrical Exhibition was held in Tokyo. It was a great success and proved a considerable stimulus to the development of Japan's electrical industry, which has since made great strides. Electricity has now penetrated into the remotest parts of the country, and has become so widespread that there are very few places, however remote they may be, that are not supplied with electric light.

There is, however, still ample room for further expansion, and, encouraged by the success of the 1918 Exhibition and with the view of a more general promotion of such enterprises, a second Exhibition is now being held at Osaka. It is in two parts, one near the Osaka Harbour and the other at Tennoji Park. Both are under the auspices of the Electrical Association of Japan.

The exhibits comprise electrical plant and machinery, electric furnaces, motors, ship's electric appliances, testing instruments, radio sets, household electrical appliances, medical instruments, agricultural implements, and, in fact, all kinds of equipment, appliances, inventions and devices in any way connected with the use of electricity. One of the features of the Exhibition is that demonstrations of the various exhibits are being given under actual working conditions.

The Exhibition was opened on March 20th, and will be continued till May 31st.

The part in the Osaka Harbour district, known as the First Section, which constitutes the principal portion of the Exhibition, covers an area of 50,000 tsubo—nearly 41 acres—of land and 10,000 tsubo—just over 8 acres—having a water front. The Second Section at Tennoji Park occupies an area of 1438 tsubo—a little over an acre. Wireless sets and electrically driven machines are on view in the Industrial Hall of this section.

The structures in the First Section are on the model of Spanish Mission architecture, into which Asiatic designs have been so blended that they are in perfect keeping with the selected locality. These buildings are said to be the first of their kind to be constructed in Japan. The area occupied by the various buildings covers 3395 tsubo—nearly 3 acres—and the total cost is estimated at 433,000 yen—say, £41,400 at present rate of exchange.

Railway Matters.

THE London Electric Railways Company is seeking powers in the present session to join the Piccadilly Railway at its terminus at Hammersmith to the disused lines of the Addison-road–Richmond lines of the Southern Railway.

WHEN the City and South London Railway was reopened in December, 1924, Lord Ashfield said that in view of the changed character of that line, it was in future to be known as "The City Railway." Evidently the proposal has not been acceptable, as in all the official references to that line now it is given the original name.

THE inhabitants of Yarm have erected a tablet on the Town Hall to the memory of the five pioneers—Thomas Meynell, Benjamin Flounders, Jeremiah Cairns, Richard Miles, Thomas Miles—who inaugurated the Stockton and Darlington Railway. The tablet also has a bronze model of the engine Locomotion, and the dates 1825 and 1926.

THE Metropolitan Railway Bill, for a tube railway from Willesden Green to Edgware-road, passed the Committee stage in the House of Commons before the Easter recess. What we believe to be an unusual step was the insertion of a clause permitting property owners to appoint, at their own expense, engineers to inspect the works in order to ascertain if any damage was likely to be done to their property. We believe also that three intermediate stations have to be provided.

ONE of the conditions under which the then Midland Railway Company secured powers in 1912 to acquire the London, Tilbury and Southend Railway was that electric traction should be adopted. That has not been done, and on March 18th the Minister of Transport was asked what steps he was going to take to cause the railway company to fulfil its statutory obligations. Colonel Ashley replied that he did not think it would be proper for him to express any opinion as to whether the railway company was or was not complying with them. He had no knowledge of any present intention on the part of the railway company to electrify that line.

A CASE of some little interest to engineers was before the Railway Rates Tribunal a few days ago. It was brought by the Association of Private Owners of Rolling-stock, and sought to increase the minimum tare of privately owned wagons from 7¼ to 7½ tons. It was claimed that wagons could not be built, under the railway companies' present specifications, within the minimum tare. Mr. Gresley, for the railways, gave evidence to the contrary, and said that now that American oak was again becoming available there should be no difficulty. The Tribunal came to the conclusion that no circumstance had been disclosed to justify any change in the charges.

IN 1921 the "Underground" group, which includes the London General Omnibus Company, carried 1100 million passengers. In 1925 it carried 1555 millions, or an increase of 41 per cent. in four years. In Greater London the number carried by train, tram and omnibus was 2911 millions; for last year the estimated number was 3687 millions, or an increase of 27 per cent. That worked out at 482 rides per head of population per year, which is, fortunately, not as great as New York, where the average rises to as much as 543 rides per head. The increase has been wholly in the omnibuses, as the railways belonging to the "Underground" carried 339 millions in 1921, but only 319 millions in 1925. The latter figure was, however, 21 millions better than in 1924.

THE inquiry into the traffic facilities of East London was completed before Easter. Some important evidence by Mr. J. P. Thomas, the operating manager of the Metropolitan District Railway, should be put upon record. He said that the limit of the train service to East Ham and Barking was twenty-four trains per hour, as that was the carrying capacity of the L.M.S. Railway east of Campbell-road Junction. That company was about to improve its signalling arrangements, and then the maximum could be raised to thirty-eight or thirty-nine trains per hour. The only way to overcome the bottle-neck at Aldgate East would be to provide a flying junction which would carry the Metropolitan Railway independently of the Metropolitan District. It would cost about £1,500,000.

THE report by Major Hall on the Fenny Stratford level crossing disaster of December 7th, as considered as a railway accident, was issued on March 30th. It will be remembered that a road motor vehicle was allowed by its driver to collide with the gates at the level crossing at Fenny Stratford Station, and to foul the up line as a passenger train was approaching. Sixteen persons were in the motor vehicle, of whom six were killed outright and three subsequently died from their injuries. The report is necessarily of some length, but it will suffice to say that in no respect is the crossing, its equipment or the action of the railway staff in any way criticised. The conclusion arrived at by Major Hall coincides with that of the two coroners' juries who investigated the causes of death, *i.e.*, that the driver of the road motor was guilty of an error of judgment.

AT a meeting of the Institution of Locomotive Engineers on March 25th a paper on automatic mechanical couplings for railway rolling stock was read by Mr. A. M. Bell. The author showed that improved couplings are essential if advantage is to be taken of the present-day greater haulage power of locomotives, but admitted that continuous brakes for goods trains would then almost be necessary. He pointed out that screw couplings had been fitted to the vehicles used on fast goods trains, and for these the coupling pole was of no use. The attaching and detaching had then to be done by the shunter going between the vehicles, and that was a great loss of time. Some very interesting information was given as to what was being done in India to meet the transition stage between the abandonment of the screw coupling and the general adoption of the mechanical automatic central coupling. In the discussion which followed the alleged advantages of automatic couplings, so far as British rolling stock is concerned, were seriously criticised by the majority of the speakers. The need for side buffers to take the lateral strains is a point that is usually overlooked by the advocates of automatic couplings in this country.

Notes and Memoranda.

AT the present time the annual production of carborundum is upwards of 30,000 tons.

IT has been proposed in the United States to use corn cobs as a packing material for sewage filters, and it is suggested that the spent cobs might serve as a fertiliser.

IT is claimed that an acetylene generating plant which is being erected in the West of Scotland by the Finnieston Engineering Company, of Scotstoun, will, with a capacity of 3000 cubic feet per hour, be one of the largest in the country.

A NUMBER of oil wells in California are producing from depths of 5000ft. to 6000ft., and the deepest producing oil well in the world, which reached a total depth of 7591ft., and is producing from a sand at 7300ft., is in the Athens field in California.

ONE of the most recently constructed grain elevators in Canada is that at Owen Sound, Ontario. It includes twenty-six circular bins, 24ft. in diameter by 96ft. high. They are of reinforced concrete, and the whole set was poured in 12½ days of working time. Movable forms raised by electric jacks were employed.

COMMENTING on the recent failure of one of the steam turbo-generators of the Victoria Falls Company, the *S.A. Mining and Engineering Journal* points out that the machine had been in commission for thirteen years, and during that time was on load for 88,000 hours, so that it had been running for over three-quarters of its life.

TWENTY-SIX natural gas transmission lines tested by the American Bureau of Mines, if taken together, would represent a transmission system containing the equivalent of 209·6 miles of 3in. pipe. The initial tests showed a leakage rate from the lines of 432,540,000 cubic feet a year. The repairs that were made reduced this leakage to 194,836,000 cubic feet.

AN unusual form of appliance for tamping asphalt road surfacing is illustrated in a recent issue of the *Canadian Engineer*. It appears to be a cast iron roller, about the size of those ordinarily used in small gardens, mounted in a substantial framing. Above it there is mounted a heavy pneumatic hammer, which presumably produces a violent vertical vibration of the roller.

A FOREMAN of the Galesburg City water department can, according to the *Canadian Engineer*, tell the position of leaks in water mains by his teeth. The man, who is deaf, has been in the water department for more than thirty years. He developed a system of placing a key or iron rod 8ft. on a water main and telling the position of the leak. He estimates according to the vibration through his teeth.

AS exemplifying the continuity of production which characterises many English engineering firms, the British Engineering Association says:—"A firm of British crane builders, George Russell and Co., Ltd., of Motherwell, have just received inquiries with regard to the repair and overhaul of two of their cranes, made respectively in 1871 and 1873, which had been in continuous use by the purchasers since those dates. It is not unusual, they state, to be called upon to supply renewals for cranes built forty or fifty years ago."

IN the field of mineragraphy Dr. F. L. Stillwell has, according to *Chemical Engineering*, of Melbourne, been investigating the occurrence of gold and silver in the natural sulphides of the Broken Hill lode, and has recognised three silver minerals not hitherto recorded. The three silver compounds discovered are pyragyrite, dyscrasite and tetrahedrite. A fourth compound—argentite—has been detected in the secondary sulphide zone, while the so-called cupro-plumbite of this zone has been determined as a aggregate of galena and chalcocite or galena and covellite.

A SHORT article in *Public Works* describes the means adopted in withdrawing a choked strainer from the bottom of a 12in. water well. The driller removed the pump, working barrel, drop pipe, &c., from the well and lowered a line of pipe having a flange on the bottom, which flange was of such diameter that it would enter the strainer. After the flange had been lowered to the bottom of the strainer, fine sand was poured into the well until the strainer was filled. A pair of wood clamps were then placed around the pipe to which the flange was attached, and a pair of jacks placed under them. With this arrangement a steady pull was exerted on the pipe, raising it and the strainer with it without injury.

WITH reference to the supply of British motor cars for service abroad, *British Industries* remarks that, generally speaking, the larger class of vehicle conforms to the stock requirements of the overseas markets in respect of such points as wheel track and ground clearance, power, engine cooling, springing, &c., and can be used wherever roads or tracks of any kind are fit to take any form of motor transport. The lighter type of car does not, as a rule, conform to the standard wheel track and its clearance, though ample for most purposes, is not exceptional. The increased overseas demand for these latter types therefore helps to prove that in very many districts overseas there is no need for a car to be in any respect different from that generally approved by the British public at home.

MUCH attention has been given during recent years to the production of arc lamp carbons giving a higher crater-brightness, and therefore valuable for use with projectors and searchlights. The designs are based mainly on a central core of rare earths, notably salts of cerium or titanium mixed with carbon. In the *Revue Générale de l'Electricité*, Monsieur J. Rey, who has been responsible for many investigations on searchlights, describes some tests made during 1924 and 1925. The maximum brightness then recorded was 539 candles per square millimetre, the average crater-brightness being 296 candles per square millimetre. Values exceeding 1000 candles per square millimetre have been reported, whereas the highest values obtained by M. Rey—with some of the latest German carbons operating at 200 ampères, with a positive of cerium oxide—gave a maximum brightness of 887 candles per square millimetre and an average of 458.

Miscellanea.

A MILL for the manufacture of pulp from waste paper is to be put up in St. Boniface, Manitoba.

IT is proposed to start the manufacture of Hume concrete pipes, by the centrifugal process, in Vancouver.

IT has been decided to hold a Norwegian Industries Fair at Oslo this year from September 5th to 12th.

A SMALL plant, of the Crozier retort type, is to be erected near Wynyard, Tasmania, to test the possibilities of the local shale for producing oil.

IT is proposed to put up a plant in Reunion for the fixation of atmospheric nitrogen and its conversion into nitrate of lime in combination with coral sand.

THE new shaft of the Dolcoath Tin Mine, in Cornwall, which struck the lode at about 1880ft. depth, is to be sunk to 2000ft. The lode is said to average 65 lb. of black tin per ton of ore.

THE output of coal from the mines of Great Britain during the week which ended on March 27th was 5,413,900 tons, as compared with 5,261,900 tons for the corresponding week of last year.

THE new turbo alternator which is being supplied by the Metropolitan-Vickers Company to the Amagasahi Power Station, Japan, is to be of 40,000 kilowatts, and will run at a speed of 1800 revolutions per minute.

SEVERAL new services of aeroplanes will be started during April, and will provide employment for 110 machines. They will include services from Berlin to London, Paris, Moscow, Basle and Malmo, all with intermediate stopping places.

A SYSTEM of central heating, by means of exhaust steam taken from the municipal electric power-house, is to be instituted in Charlottenburg, Germany. The steam, at a temperature of about 170 deg. Fah., will be distributed by underground mains.

A VERY promising deposit of alluvial tin and also a lode has been discovered in the North-Western part of Tanganyika and the Bukoba district. Samples taken from the discovery have been very well reported upon and a capital project is under consideration.

A DAIREN paper reports that an underground lake 240 yards wide and 100ft. deep has been discovered in the Chinchow district. Plans are in progress to drain the water on to the paddy fields, which have suffered from inadequate irrigation facilities for many years.

IT is reported that work on the Wenallt Reservoir of the Cardiff City Council has been suspended on account of the difficulty of making it water-tight, which has been caused by geological disturbance of its floor. The amount expended so far on the reservoir is said to be £105,000.

THE Polish Minister of Finance has been authorised to make a reduction of 90 per cent. in the import duty on machinery and apparatus not manufactured in Poland and destined for the equipment of new industrial establishments. Since the reduction is intended to facilitate the equipment of factories on the most modern lines it will not apply to machinery of old type.

THE first of the four new machines which will make the International Paper Company's Three Rivers Mill, Quebec, the largest newsprint mill in existence, has just been operated for the first time. It made the first 10 tons of newsprint at a speed of 800ft. of paper a minute without a single break. Installation of the four new machines is expected to be completed by July, and will give the mill a capacity of 700 tons a day. This production will be equivalent to two acres of newsprint a minute, four million 24-page newspapers a day.

IT is reported from Buenos Aires that a contract has been signed with the Compania General de Obras Públicas for the construction of a hydro-electric station at the port of Buenos Aires. According to the report, the station will rank as one of the largest electric installations in the world, for it is to contain five sets of generators, each of 130,000 horse-power, making a total of 650,000 horse-power. Two sets only are to be proceeded with at first, one of which, it is expected, will be in operation by the end of 1927 or early in 1928.

THE President of the Argentine Republic, after a personal study of the difficulties encountered by large vessels entering the port of Buenos Aires, has urged Congress to provide the necessary sum—10,000,000 pesos, in addition to 5,000,000 pesos already discussed, but not granted, to bring the facilities at the port up to modern requirements. A sum of 20,000,000 pesos has already been spent on the works, but these do not quite provide the desired facilities for berthing the larger steamers. It is expected that Congress will vote the necessary funds and that the port works will be completed before the end of the year.

PLANS for a big addition to the Port Colborne, Ontario, plant to be made this year, at a cost of approximately 750,000 dollars, are being prepared by the International Nickel Company. The decision to add the new unit has been prompted by the ever-increasing demand for electrolytic nickel. Although the plant is at present equipped to produce 350,000 lb. of this electrolytic nickel per month, the addition will permit of the refining of 600,000 more pounds, bringing the total monthly electrolytic production to nearly 1,000,000 lb. The new unit is only one of six of similar size that are contemplated by the company in the future to turn its entire output into electrolytic nickel should the demand arise.

A SCHEME for the extensive development of the resources of the southern tablelands of New South Wales is reported, in the *Industrial Australian*, to be under way. A syndicate has been successful in securing the investment of £1,000,000 of British capital in the project. Large tracts of land around Marulan, Berrima, and Mittagong are to be secured to exploit the mineral and other resources, and the scheme will embrace the opening up of the Marulan lime deposits and the vast timber areas in the Mittagong district, while draft contracts have been completed for the immediate establishment of a large cement producing plant at Bong Bong. Associated industries are involved, including shale, coal, lime, bricks, metals and timber.

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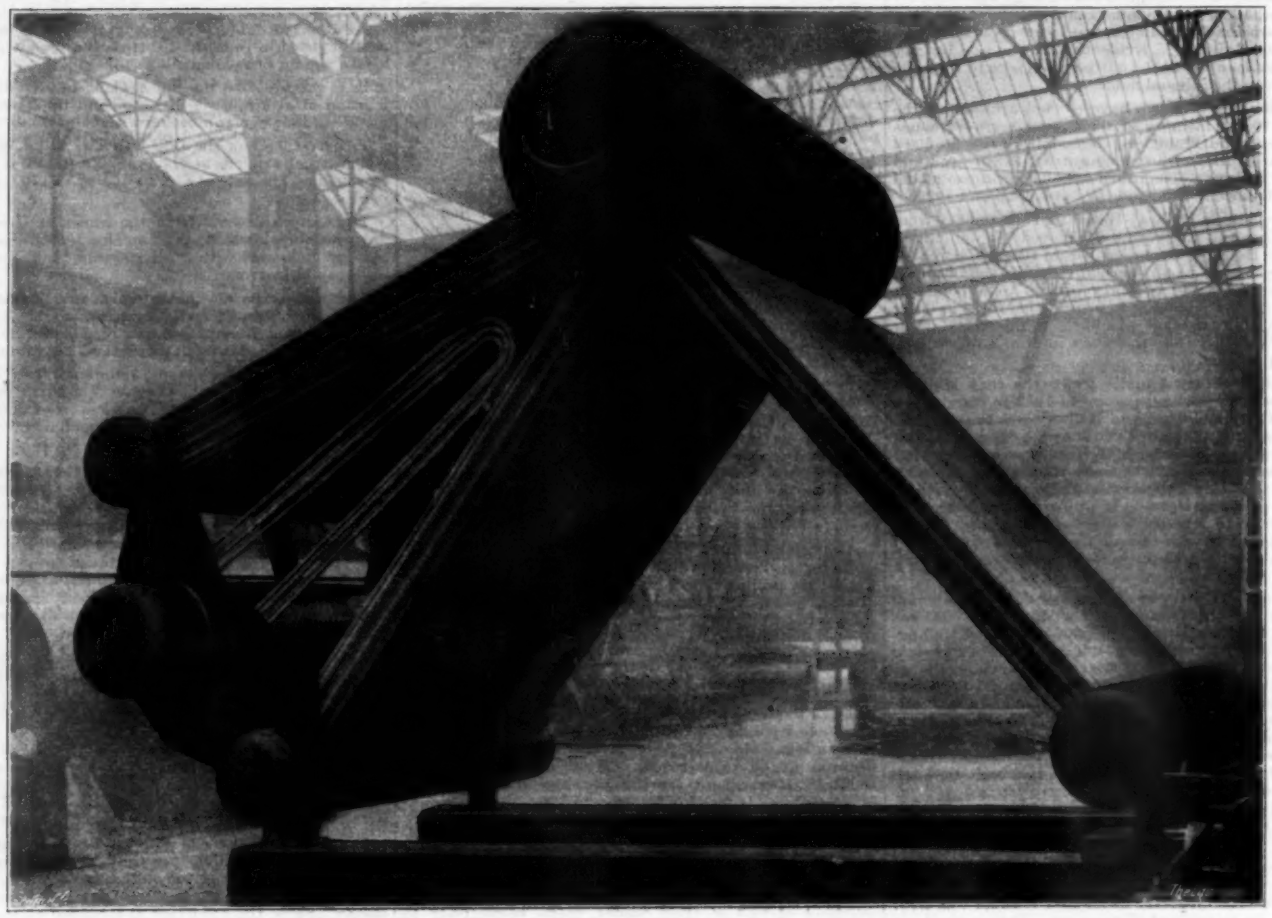

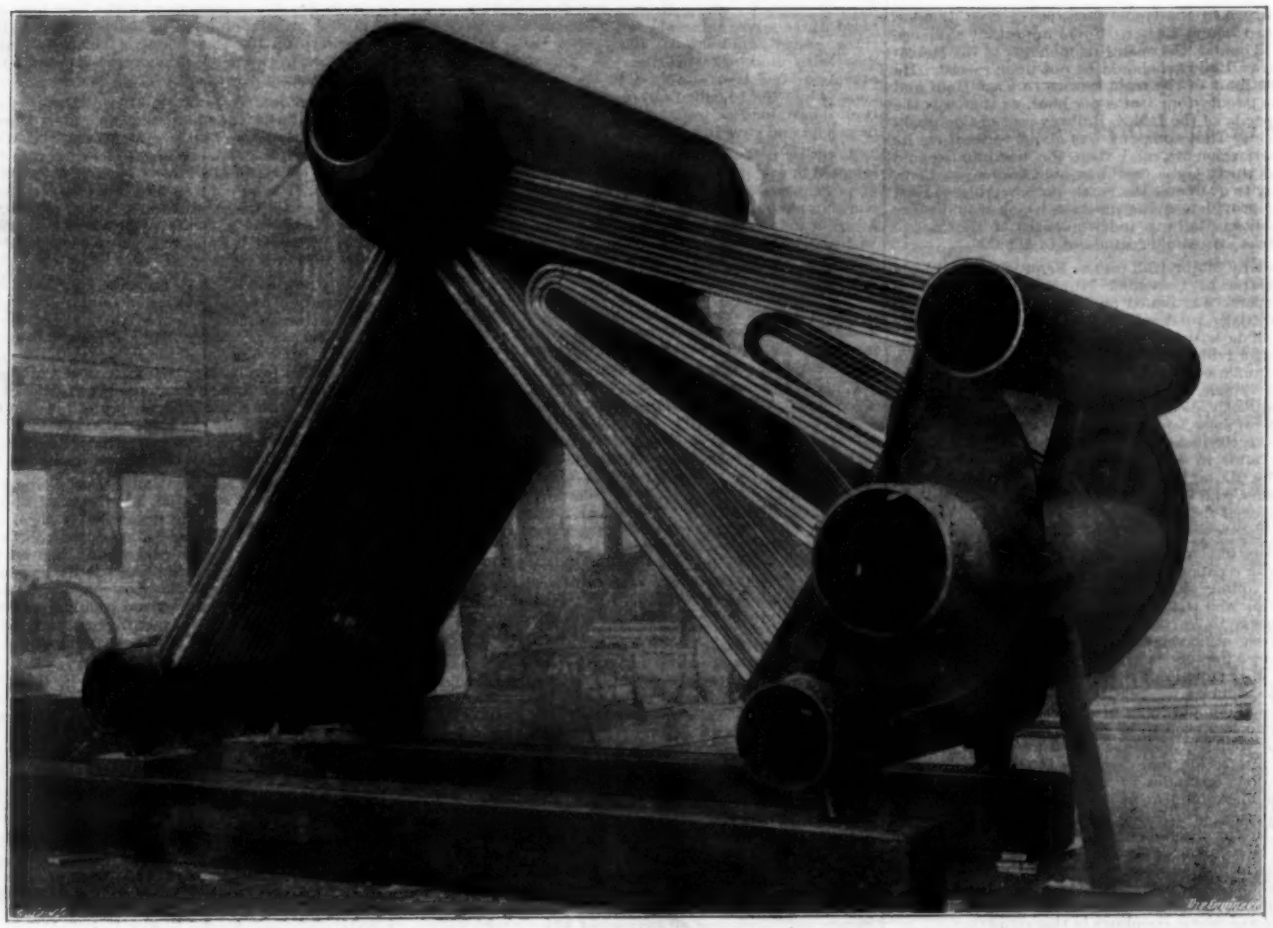

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THE ENGINEER.

APRIL 9, 1926.

The Privately-owned Railway Wagon.

The privately-owned wagon has come into its own. Having often in the past been indicted as a nuisance, a bane, and a bar to progress, and generally cursed uphill and down dale, it appears from evidence given by Sir Ralph Wedgwood, on behalf of the railway companies, before the Coal Commission, that were all railway wagons owned by the companies there would be a saving of only one penny per ton on the whole of the rail-borne coal and coke traffic. Those who see in the shunting of privately owned wagons into groups for their various owners an apparently great waste of energy realise neither the history nor the purpose of the private owner's wagon. It is older than the railway itself, and when in the course of time the railway companies became carriers they handled merchandise only. They even went so far, under their various empowering Acts, as to exempt themselves from the necessity of providing wagons for what is known as Class A traffic. Hence it may be said that the private ownership of wagons has been invited, encouraged and enforced. The owner, on his part, has no desire to be relieved of his responsibilities in this respect, despite the fact that the provision or hire of wagons is an expensive matter. The report of the Coal Commission remarked that it is not usually realised how large a proportion of the capital cost of establishing an important new colliery has to be allocated to the provision of railway wagons. It quotes Mr. C. P. Markham as testifying that on a capital outlay of from 1¾ to 2 million pounds some £300,000 must be set aside for the provision of wagons. So great an expenditure, needless to say, would not be incurred were it not absolutely necessary. Several reasons may be given for such a necessity. There is, for instance, the fact that a coalowner cannot use a railway-owned wagon for storage purposes, whilst he may fill his own trucks when trade is quiet and incidentally, by so doing, keep his colliery going. Furthermore, if the number in his possession be sufficient he is guaranteed a supply that corresponds with his trade. Were all trucks supplied by the railways some preference—more by accident, perhaps, than deliberation—might, in times of pressure, be shown towards a firm with the greater business. Then, finally, the railway companies themselves have had no reason to embark on such a big financial venture as the purchase of all the privately owned wagons would entail. It is true that the former North-Eastern and the Scottish companies used to provide the trader with railway-owned wagons, but their coal traffic was mainly to ports, works, &c., on their own systems, and, thus, the wagons rarely left the owning lines. The Midland Company's attempts, in the 'eightles, to buy out the private owner completely failed. The fallacy that the elimination of the privately owned wagon would reduce the empty haulage is once more confirmed by Sir Ralph Wedgwood's evidence that "a substantial saving is possible in theory, but there are practical difficulties and North-Eastern experience is not encouraging. It is doubtful if much would be realised under that head."

The privately owned wagon has thus been justified and is to be allowed to continue. The Coal Commission suggests two changes, both of which have merits, are possible, but are not readily attainable. The first is the formation of district pools which shall take charge of not less than, say, 50,000 of the wagons usually employed in that district. As an economy may be expected from such wagons being available for general user, it is recommended that, in order to win the support of the owners, those in the pool should have the economies effected returned to them in the shape of a rebate. The other change proposed is the gradual substitution of 20-tons wagons for those of 8, 10, and 12 tons now in use. Support for that course is to be sought by the granting of a rebate where the large wagons are used. That was the plan which Mr. Gresley proposed in his paper, "Wagon Stock on British Railways," read at the Institute of Transport on February 5th, 1923, and which was put into force by the Great Western in the following October. From the railway point of view the big wagon has many advantages. The load per train is greater; the higher drawing capacity of the present-day locomotive is better utilised; there is less dead weight; the siding space occupancy is reduced; and there is less coupling and uncoupling for the weight conveyed. Unfortunately, the companies do not control the situation. The coal-loading plant at the pit, and the hoists and tips at the ports, have been built to handle the smaller wagon. As most of the docks to-day are railway owned the remedy for the conditions at them rests in the companies' own hands. In that relation the Great Western Company has, within the last two years, spent two million pounds on the equipment at the docks in South Wales—all now owned by that company—and 20-ton wagons can now be taken at all those ports. With the coal trade, particularly in South Wales, in its present bad state it is too early yet to say whether that step and the granting of a rebate for carriage when a 20-ton wagon is used have been warranted. Former efforts in that direction by other companies have not been satisfactory. In the discussion which followed Mr. Gresley's paper, mentioned above, Mr. J. Pike spoke of what the London and North-Western did at Garston. Tips to accommodate 20-ton wagons were provided, but the extra expense was wasted, as the colliery owners declined to use the larger wagon because they wanted one that could be used in common, whether for carrying export coal or coal for domestic purposes. Sir Sam Fay went further. The Great Central offered a rebate of 3d. per ton if 20-ton trucks were used, but all to no avail. Eventually he persuaded a firm of coal exporters to charter a complete train and to keep it intact, but after two or three months the arrangement came to an end and the wagons found their sole occupation in conveying locomotive coal to the company's engine sheds. On the other hand, the North-Eastern gave no rebate for the use of the 20-ton wagon. Its view was that the coalowner and the consumer obtained advantages from the increased capacity of their respective sidings and from the general modernising of the methods of carriage. It is noteworthy, furthermore, to hear from Sir Ralph Wedgwood that the experience of the North-Eastern had been that the economies realised from the adoption of the larger wagon were real, but not great. In addition to the conveyance of coal for export and industrial purposes there remains that for the coal merchants who deal with domestic supplies. The majority of those merchants, except in the larger towns, are men in a small way of business who cannot afford to have 20 tons of each class of coal. They object, too, to the bigger wagon because of the greater breakage it involves, with a consequent larger proportion of slack. Such men will continue to use the 10 or 12-ton wagon—indeed a smaller wagon would usually suit their purpose better still—and so will lose the rebate.

The issue of the report of the Coal Commission has revived an interest in a 40-ton wagon. For such a wagon there is, in our opinion, no opening in this country except for certain unusual purposes. Among the latter may be named traffic that has to be unloaded on stacking ground in the open, *e.g.*, locomotive coal and bricks. It is now over a

quarter of a century since the North-Eastern, Lancashire and Yorkshire, and Caledonian companies followed American methods in the matter of the big bogie wagon. Yet to-day there are, out of over 700,000 railway-owned wagons, only 1056 of over 20 tons capacity, of which the London, Midland and Scottish owns 243, the London and North-Eastern 797, the Great Western 15, and the Southern 1. Of the total, 397 are open goods wagons and 516 are mineral wagons. Nearly all the movements into, out of, and in goods warehouses are made by turntables, whilst traversers are used to transfer wagons from one road to another and hoists are provided for taking them to and from the different floors of warehouses. None of this equipment is suitable for bogie wagons. Such trucks, too, would occupy too much space at the loading decks in goods warehouses. They are, therefore, of little service for merchandise traffic, whilst for mineral purposes they would only aggravate the difficulties that stand in the way of the adoption of a 20-ton wagon. Whether for goods or mineral traffic, the latter is ideal, and we hope that one result of the Coal Commission will be co-operation between the railways and the coalowner to secure its general adoption, and that the privately owned wagon, whose value has at last been appreciated, will be perpetuated.

The Heat Transmission Aspect of a Power Station.

There are many ways of looking at a power station. The electrical engineer, the mechanical engineer, and the more recently developed combustion engineer each has a point of view produced by his special interest and training. They would; however, all concur in regarding a power station essentially as a means of converting the heat of coal into electricity, whatever step in the process each might consider as the most important. That there could be another aspect of equal importance from a technical point of view would probably not occur to them. Nor is this surprising, for the ceaseless efforts which are made to improve the efficiency of this conversion of heat into electricity tend to divert attention from other matters. There is, nevertheless, a characteristic common to all stations which is worth considering. One may quite properly regard every power station primarily as a means of transmitting heat from the furnaces to the cooling water, and only incidentally as a means of utilising part of this heat to the best advantage. The two functions are interlinked, but since the utilisation of a given quantity of heat can only be effected by the transmission of a very much larger quantity, the handling of this larger quantity is a matter of primary importance. Very few power stations in the world can turn into electricity as much as 20 per cent. of the heat they handle, and 15 per cent. is accounted a very creditable figure for an ordinary station. Hence, so long as from five to seven times as much heat as can be turned into work has to be dealt with by power station equipment, heat transmission will continue to be the point on which design must largely turn. Nor is there much chance of any very great change in this respect in the future. Efficiencies creep up very slowly, and however perfect the generating plant may become, the ratio of heat utilised to heat produced is definitely limited by the range of temperature which natural conditions forbid us to exceed.

Few people realise how relatively enormous are the heat transmitting surfaces in a modern power station. At Barton, for example, according to figures given by Mr. Pearce in a paper before the Institution of Civil Engineers, each of the nine boiler units has an aggregate heat-transmitting surface of 45,972 square feet, inclusive, of course, of the economiser and the air heater. Each of the three main condensers has a surface of 40,000 square feet, and each of the three air coolers has a surface of 12,800 square feet. Thus, in the main units alone we have an aggregate heat-transmitting surface of 572,148 square feet, without counting such things as feed-water heaters, oil coolers and other apparatus of similar nature. It is difficult to realise the magnitude of these figures. Put in another way, it may be said that to serve the requirements of generating plant with a maximum continuous rating of 82,500 kilowatts, metal surfaces, covering more than 13 acres, or equal to the area of a strip of land a mile long by over 36 yards wide, have to be provided for heat to flow through. Every square inch of these surfaces is, or should be, doing its share of heat transmission when the whole plant is running. This can only be the case when both sides are clean, so that the operating engineer has 26 acres of metal, or the size of a large field, to keep in order. None of these surfaces can be inspected or attended to effectively while working, and although a certain proportion of them, such as the outside of the condenser tubes, need no attention, others have to be the scene of a constant battle between dirt and the engineer. The moment dirt begins to be deposited the efficiency of heat transmission begins to fall off. The provision of soot blowers in the boiler plant and sometimes of chlorinating apparatus for the condensers may extend the periods of continuous service, but there is still the same amount of metal to keep free from dirt and to protect as far as possible from deterioration by corrosion. The question whether this surface could not be reduced is an insistent one. The cost of boilers, economisers, superheaters, air heaters and condensers increases in almost direct proportion to their surfaces, and the cost of housing them and providing the necessary piping and ducts to serve them is also determined largely by their size. The maintenance also of surfaces measured in acres is a serious matter. If it is properly done it is expensive in labour, and involves lengthy periods of plant out of service; while if it is neglected economy instantly suffers. The only way of reducing surfaces without affecting the thermodynamic characteristics of the plant would seem to be by increasing the average rates of heat transmission per square foot. If all the tubes in a boiler or condenser could be arranged so as to do more or less the same work as those which are the most active at present, the average rate of heat transmission could be notably increased without imposing any more severe conditions on the metal than it now withstands, and the surface could be correspondingly reduced. This is a matter of design pure and simple, and is separate from the question of increasing the rate of heat transmission with a given temperature difference. What possibilities there are in this direction are a matter which would form a much more useful subject for research than much of the research work being done at present. The only factors which are possible of modification would seem to be the nature of the conducting metal, the physical state of its surfaces, and the velocities of the gases or liquids taking or giving up heat. If we cannot get more than about 5 B.Th.U. per square foot per hour into an economiser per degree Fah., for example, it is just as well to know wherein the physical limitation consists.

As regards the broad question of the reduction of heat transmitting surfaces in a power station, there are, of course, other considerations besides those of the consequent reduction of cost and size of apparatus. The scale in a boiler or condenser will be roughly proportional to the amount of work the plant has done since the last cleaning. The permissible limit of thickness, whatever it may be, will therefore be reached in half the time if the rate of heat transmission is doubled. Indeed, with a high rate of heat transmission it may well be that a thickness of scale which would be permissible for a low rate may be unsafe in a boiler, so that the high duty plant may have to be shut down for cleaning more than twice as often as one working at half its rate of steaming per square foot of surface. Many engineers insist on a low average rate of heat transmission in boilers and condensers from this point of view alone. They have more latitude in choosing a time when the plant is to be shut down for cleaning, for if the normal period of working should be exceeded, the falling off in efficiency will be slow. This is an important consideration when the total number of units is small. Moreover, to clean a given thickness of scale twice from a high-duty boiler will cause the loss of more boiler hours than the removal of the same thickness once from a boiler of twice the surface, on account of the time lost in making ready. There is thus much to be said for low heat transmission rates under present circumstances, but all the arguments turn on the question of cleanliness. Anything that can be done to prevent heating or cooling surfaces from getting dirty will not only automatically bring about higher average rates of heat transmission, but will enable high rates to be employed without danger. It would, for example, obviously be better if a boiler could be so designed that flue dust would not rest on the tubes, than to rely on the periodical removal of the dust by means of soot-blowing devices. If designers could do more to arrange surfaces at such inclinations that loose dirt could not accumulate on them and to provide for such velocities over the surfaces that deposits were discouraged, they would be moving in the direction of reduced costs and greater efficiency. Dirt is the greatest enemy to heat transmission, and prevention is better in every way than cure. Comparative tests between different types of boiler plant made when new, and again after, say, three months' service, especially if studied in the light of the labour and steam spent in maintaining them in good order during the period, would indicate how much design has to do with the maintenance of efficiency of heat transmission. Any modification of design which would tend to keep surfaces clean would be of inestimable benefit to the engineer who has many acres of heat-transmitting surface to keep in good order. Moreover, if, either by a greater average cleanliness or by procuring a higher rate of heat transmission in some other way, the present enormous requirements of a power station in the matter of surface can be reduced, a notable step will have been taken towards reducing capital costs and lessening the maintenance expenses of a plant.

Obituary.

ERNEST LEOPOLD AHRONS.

Everyone of our readers who takes an interest in locomotive design and locomotive history will hear with sincere sorrow of the death of Mr. E. L. Ahrons, on March 30th. There are few English engineers who combine so fully as Mr. Ahrons did an intimate knowledge of the principles of locomotive engineering with a complete knowledge of locomotive history. The great series which he completed but recently in our columns will be fresh in the minds of all, but many will recall with little less clearness the admirable descriptions contributed to our series entitled "Short Histories of Famous Firms," in which he dealt with the origin of many British companies which built locomotives in the last century. His practical acquaintance with locomotive design and operation gained by ten years' experience at Swindon, first as pupil and then in the drawing-office, enabled him to speak with critical appreciation of the successive steps in locomotive development. His articles and books have therefore a character of their own and may justly be regarded as of real technical educational value as well as of historical interest.

Mr. Ahrons was the son of Mr. Leopold Ahrons, of Bradford, and he was born in that town and educated in its Grammar School. In 1882, when he was sixteen years of age, he went to Yorkshire College, Leeds, where he took one out of three advanced scholarships and distinguished himself by gaining first prizes in engineering construction, mechanism and machinery. Leaving the Yorkshire College in 1885, he went to the Great Western Railway Company's works at Swindon as an engineering pupil until 1888, and from then until 1890 he worked in the Swindon drawing-office. In the last-named year, 1890, he accepted an appointment with Fleming, MacFarlane and Co., of Middleton, as chief draughtsman, and two years later he was appointed by the Ecole Khédiviale d'Arts et Métiers, Boulac, Cairo, to the position of Engineer and Manager in the Government workshops, but owing to ill-health he had to resign that appointment in 1898 and returned to England, where he became engineer-in-charge of the General Department of Henry Simon, Ltd., of Manchester. Between the years 1902 and 1917 he held various other positions and did a certain amount of consulting work. During the war he was appointed Trade Officer at the Department of Overseas Trade (Development and Intelligence) and retained that position until 1919. Since that time he was engaged almost wholly upon literary work, writing many articles for The Engineer, for the *Railway Magazine*, and for other papers. But besides his numerous articles he was the author of several well-known books, amongst which "The Development of British Locomotive Design," published by the Locomotive Publishing Company, is perhaps the best known. The same company published a volume by him on "Repairing Locomotives," and another on "The Lubrication of Locomotives," whilst Isaac Pitman and Sons published three little primers by him, one on "The Steam Locomotive" as a whole, another "Steam Locomotive Construction and Maintenance," and the last on "Steam Engine Valves and Valve Gears." He also gave Mr. J. G. H. Warren some assistance in the preparation of "A Century of Locomotive Building," which was published by Robert Stephenson and Co., Ltd., in 1923.

Mr. Ahrons was a member of the Institution of Mechanical Engineers, of the Institution of Locomotive Engineers, and of the Newcomen Society. At one time he used to be a fairly regular attendant at the meetings of the Institutions, and was always to the fore when locomotive matters were under discussion, but of recent years his health had not been all that could be desired and his visits to town became rarer and rarer.

Whilst his last series of articles was running in The Engineer we had many inquiries as to the possibility that it would be republished in book form. On its completion we gave Mr. Ahrons full permission to make what arrangements he pleased with regard to their re-publication in a

volume, and we understand that he had taken preliminary steps to bring them out in that form. We are, however, unable to say at the moment whether his death will prevent the completion of the work, though we have some hope that the Locomotive Publishing Company, Ltd., which had the matter under consideration, may decide to proceed with the work.

ARTHUR LLEWELLYN LLOYD.

THE death of Mr. Arthur Llewellyn Lloyd, chairman of Thomas Piggott and Co., Ltd., is announced as having taken place on March 28th. Mr. Lloyd, who was the third son of the late Mr. Sampson S. Lloyd, for many years chairman of Lloyd's Bank, was born in Birmingham and was educated at Uppingham. He afterwards spent some years at Middlesbrough in the engineering works of Hopkins, Gilkes and Co. Subsequently, on the purchase by his father of the business of Thomas Piggott and Co., engineers, Spring Hill, Birmingham, he joined that firm, became a director, and was chairman for many years. He was also a director of the Mint (Birmingham), Ltd., and New Hudson, Ltd. He was seventy years of age.

Finance and Industry in France.

(By our Special Correspondent in Paris.)

To what extent British engineering industries will be able to participate in continental trade is a question that must be settled before manufacturers can trace out their future line of policy. The changes that are continually taking place in European economic conditions must be periodically examined, for it is only with a knowledge of the situation that makers can hope to adapt their methods to the altered requirements of trade and industry abroad. Most European countries, finding themselves under the financial necessity of restricting purchases of foreign goods, took advantage of their extensive war factory equipments to manufacture many classes of products that were formerly imported. In some countries certain serious drawbacks have accompanied that course. In France, for example, there is the difficulty of conciliating the opposing interests of manufacturing industries and of agriculture, for owing to the labour scarcity they cannot develop along parallel lines. Such a competition is necessarily in favour of the manufacturing industries, which attract labour by the offer of higher wages and easier conditions of living. Hence French industries have developed at the expense of agriculture, and there are many who regard this industrial expansion as a high price to pay for the threatened decline of agriculture in a country which has always depended mainly for its prosperity upon an unrivalled agricultural wealth. Furthermore, the conflicting interests of industry and agriculture present difficulties in the way of carrying out international commercial agreements. It is hoped, by "industrialising" agriculture and adapting engineering methods to farm operations, to develop production in a way that will ensure a large export trade, in which event the necessity of providing markets for surplus produce will influence negotiations for the carrying out of commercial treaties. Another matter pointing to a change in the economic situation is the effort of the State to secure a monopoly of oils in France. If that attempt were to succeed it would inevitably be followed by other arrangements aiming at a complete upheaval of the existing methods of distribution. The entire dependence upon British and American sources of oil supply is causing great concern in France, and during the past two or three years the French have been looking to Russia as a means of relieving them of what they regard as a heavy tribute they have to pay to countries with a normal currency. The French Government therefore entered into arrangements with the Soviet whereby special advantages would be accorded to France for obtaining practically the whole of its supplies of oil from Russia. To carry out that it was necessary to institute a State monopoly of oils, and that the Senate refused to consider, and a compromise on the Budget was only effected by reserving the question of oil monopoly for future discussion, which means that it is temporarily shelved.

As the object of most continental countries, and of France in particular, is to cut down the expenditure on foreign goods to an absolute minimum, it follows that the fiscal system for the protection of home industries is receiving special attention. And when, in addition to being an economic factor, import duties are regarded as an indispensable source of revenue, it may be assumed that further increases in them will become inevitable. If there has been so much delay in raising the import duties it is because opinions are greatly at variance as to the conditions under which they should be imposed. There is a very strong feeling in the country in favour of a form of moderate protection which will be sufficient to ensure the prosperity of home industries and will at the same time benefit trade and commerce. It is, however, difficult to fix upon a standard of moderation when the financial and industrial conditions are constantly changing, and the preference for moderation is being overruled by a belief in the efficiency of higher tariffs as a means, principally, of bargaining for advantages when negotiations are entered into for commercial treaties, and of providing additional revenue. There is no doubt that, in the case of France, the increase of 30 per cent. in import duties has been voted primarily with a view of providing the State with funds wherewith to balance the Budget. There is no immediate necessity for such an increase to protect home industries, and the augmentation which will come into force almost immediately will have the effect of practically excluding British goods at a time when British manufacturers are beginning to see an opportunity of renewing business relations with France. The 30 per cent. increase in import duties is regarded as a temporary measure pending the passing of the new Tariff Bill, which, it is stated, will be introduced into the Chamber of Deputies in about three months' time, although it is quite possible that the proposed measure will be held back until some idea can be gathered of the rate at which the franc may be stabilised. In any case, it is certain that the forthcoming Tariff Bill will raise appreciably the import duties all round, and the tendency towards a more intensive protection will become accentuated mainly with the idea of granting concessions wherever necessary in order to secure foreign markets for French goods and products. The same tendency is observable in most continental countries. Each is anxious to secure the greatest possible benefit when the situation becomes stabilised, and a serious trouble lies in the fixing of minimum tariffs. It is probable that frequent adjustments will have to be made before continental countries can settle down finally to normal conditions of industrial and commercial activity.

In view of the heavily increased import duties into France, and of the growing competition for trade in other countries, it would appear that British manufacturers will find themselves, for the time being, in a less favourable position for doing business on the Continent. Nevertheless, the heavy burdens imposed abroad on British goods will probably be found to be less serious than the charges placed upon continental industries. Apart from Germany, which has been particularly fortunate in relieving its manufacturers of super-taxation, nearly all countries find it impossible to avoid the fiscal burdens which are necessary to put their finances in order. The sensational depreciation of the franc has convinced the French that they can no longer delay the necessary measures to save the country from an economic disaster. So long as the franc declined without unduly shaking confidence in the future the results were favourable to cheap production and to the development of a considerable export trade, but when the depreciation assumed the appearance of a collapse and the franc was regarded as of dubious value, confidence disappeared altogether, prices rose to a disquieting level, raw material advanced rapidly, wages increased and manufacturers found it difficult to fix selling prices. The situation is one which was long predicted. When a country has to depend upon sources of supply from abroad it cannot exist with a debased currency. The efforts of France to become self-supporting with the aid of colonial products have hardly yet begun to be realised, and many years will elapse before capital can be usefully employed in producing cotton, wool and grain, even if it were possible to provide for the deficiency of labour in the African colonies. Therefore France has had to make a final effort to put her affairs in order. Heavy taxation is falling upon the manufacturing industries and production costs are rapidly increasing. If the present advance should continue manufacturers will soon lose the benefit they have derived from a temporarily debased currency, and the final result will inevitably be a levelling up of costs to above those, probably, prevailing in other countries.

Now that taxes are to be imposed with the idea of stabilising the franc an improvement in relative values will place French manufacturers in an anomalous position. The greater the improvement in the franc the more pronounced will be the relative burden on French makers. The situation may be summed up in a few words. As the foreign industry is required to bear burdens from which it has been relieved to a large extent the production costs tend to rise, and the rate of progression will depend upon the rapidity with which the franc improves. An attempt will be made to stabilise the franc at a level which will avoid a complete upheaval of the industrial situation, and industry will be protected by an elaborate system of import duties against the competition of countries with a normal currency. The hope of British manufacturers lies mainly in the arrangements that can be made to secure fair treatment by reciprocal concessions under a commercial agreement which appears indispensable as soon as the pending financial negotiations are completed.

Literature.

Applied Elasticity. By S. TIMOSHENKO and J. M. LESSELLS. East Pittsburgh: Westinghouse Technical Night School Press. Price not stated.

BOTH the authors of this book are attached to the Research Department of the Westinghouse Electric and Manufacturing Company. Mr. Timoshenko, formerly Professor of Mechanics at the Kiev and Petrograd Polytechnical Institutes, is responsible for Part I. of the work, dealing with the analysis of stress and the theoretical side of the strength of materials. In Part II. Mr. Lessells—he will be recalled as the author of a paper presented before the Institution of Mechanical Engineers in December, 1924—deals with the experimental aspect of the subject. In no important respect does the book suffer by transhipment from the country in which it was printed, a fact amply explained by the circumstance that one of its authors is—or was—a Russian, while the other, so we infer, is—or was—an Englishman. The numerous footnotes in both parts of the book show that the authors have relied far more on European, principally British, authorities and sources of information than upon American, so much so, in fact, that we can easily imagine the book receiving a warmer welcome in this country than in the United States. The work of both authors appears to us to be very well done. Neither treats his subject in an elementary manner—Mr. Timoshenko's portion leans unavoidably to the mathematical side—yet both succeed in keeping within the bounds of an essentially practical discussion. The book is refreshingly up to date. Mr. Timoshenko, for instance, gives what will be to many a sufficient account of the hydrodynamical and membrane—or soap film—analogies for the distribution of torsional stress, and of the Rayleigh-Ritz method of calculating approximate values for the natural periods of vibration of structures, such as bridges and ships. In his treatment of fatigue in metals Mr. Lessells duly stresses the importance of the work recently done in this country by Gough, Haigh, Jenkin, Lea, and other investigators. In discussing hardness, he does not omit to refer to Mr. Herbert's pendulum tester—although he perhaps assumes too readily that the theory of that instrument was completely and satisfactorily explained in the letters from Mr. Timoshenko which we published in our issues of July 6th and September 7th, 1923—and in his treatment of impact tests pays much attention to recent British and continental investigations on this very important practical aspect of strength in engineering materials.

SHORT NOTICES.

Fuel Oil Viscosity-Temperature Diagram. By Lieutenant Commander G. B. Vroom, U.S. Navy. London: The Simmons-Boardman Publishing Company. 12s. 6d.—This publication is not really a book, but it provides in a very compact form such a mass of information that generally requires an extensive set of tables, that it may perhaps be included among these notices. It is, in fact, a stout card, about 11in. by 14in., on which there is printed a rectangular diagram and which has a pivoted celluloid arm. The principle of the instrument depends on the fact that if the viscosity curves of fuel oils are plotted to a double logarithmic scale, they appear as straight lines and pass through a common point on the diagram, which has been determined experimentally. The celluloid arm is pivoted at this point, and it follows that if the viscosity of the oil at any temperature is known, the viscosity at other temperatures can be determined by following the direction of the arm when laid on the known point. The diagram can also be used for the conversion of viscosities from one system of annotation to another of the four commonly used in America.

Industrial Furnaces. By W. Trinks. New York: John Wiley and Sons (London: Chapman and Hall). 1925. 27s. 6d.—This volume is a continuation of the author's work on furnaces, and deals with the practical side of the subject, whereas the first volume is of a theoretical nature. It should, we think, prove very useful to any engineer who has to do either with the construction or working of commercial furnaces. In some directions the subject matter, naturally, specially relates to American conditions, such, for instance, as that part dealing with the burning of natural gas, but taken all round the remarks of the author should prove of value to engineers the world over. Especially so should that section dealing with powdered coal, which includes descriptions of several systems and an explanation of the process of burning the fuel. There are chapters on electrical furnaces, the control of furnace temperatures and the comparison of various types of fuel. The author makes a very frank statement in saying that "as a rule the fuel practice in American steel plants is so wasteful that no blast-furnace gas is left over for use in heating furnaces," but he goes on to say that where this gas has been used good results have been obtained. The book is well printed, profusely illustrated, and is noteworthy, on account of the entire absence of anything approaching advertisement among the text.

BOOKS RECEIVED.

Transactions of the Engineering Association of Malaya. 1924. Vol. IV. Kuala Lumpur, F.M.S. 1925.

Year Book of Wellington Harbour Board, New Zealand. Wellington: Published by the Board. 1926. Price 2s. 6d.

The Condor Engine (Series III.). London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 4s. net.

The Colliery Year Book and Coal Trades Directory, 1926. London: The Louis Cassier Company, Ltd., 34, Bedford-street, W.C. 2. Price £1 1s. net.

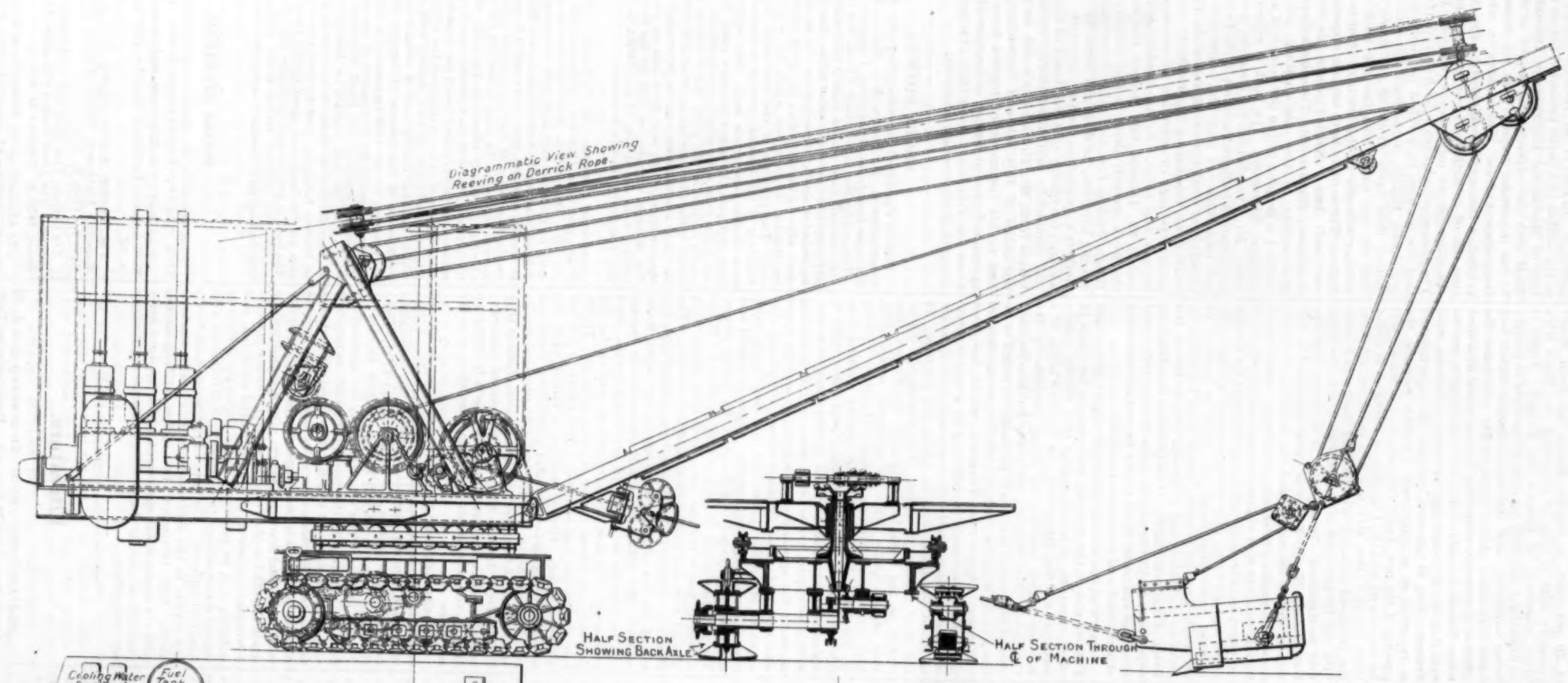
The Engineer and the Prevention of Malaria. By Henry Home. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 13s. 6d. net.

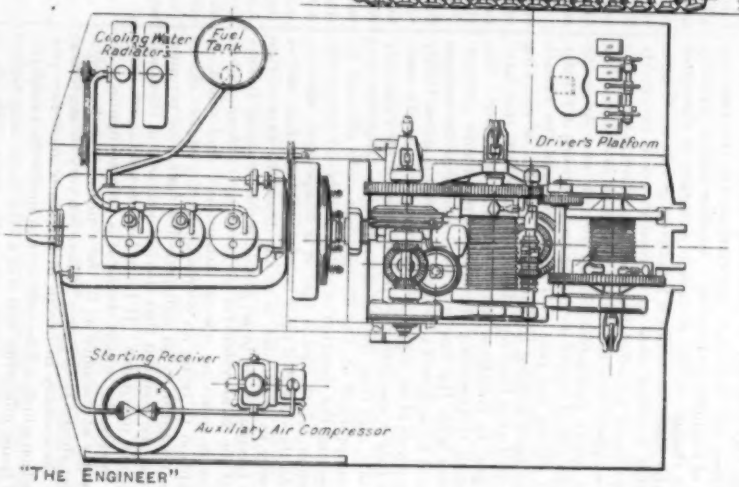
Hertha Ayrton, 1854–1923: A Memoir. By Evelyn Sharp. London: Edward Arnold and Co., 41 and 43, Maddox-street, W. Price 15s. net.

SELF-PROPELLING DRAGLINE EXCAVATOR OPERATED BY AN OIL ENGINE

RUSTON AND HORNSBY, LTD., LINCOLN, ENGINEERS

(For description see opposite page)





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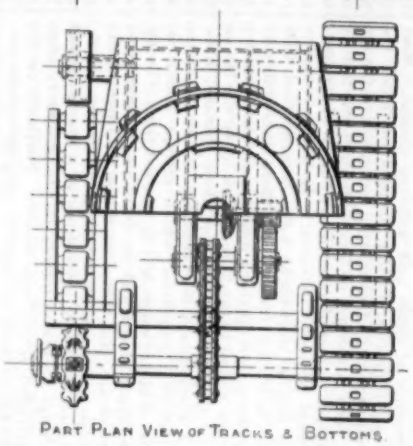
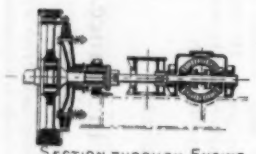
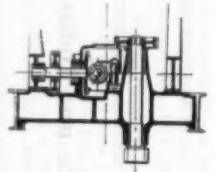


Part Plan View of Tracks & Bottoms.

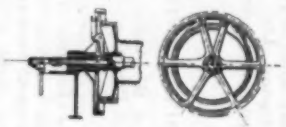


Section through Engine Flywheel & Transmission Gear

Section Through Slewing Gear



Section through Transmission Shaft Gear Box & Bedplate.



Section Through Drag Clutch.

SWAIN Sc.

An Oil-Engine-Driven Dragline Excavator.

WE recently inspected under test at the works of Ruston and Hornsby, Ltd., Lincoln, one of a series of oil-engine-driven excavators, cranes and navvies which the firm has recently placed on the market. Most digging and lifting appliances of the kind are steam operated, and good results are obtained with that type of machinery. But there are many districts in which such machines are called upon to work where suitable boiler water is exceedingly scarce, whilst oil fuel is relatively cheap. Under such conditions the oil-engine-driven machine has considerable advantages, not alone in the matter of cheap fuel and the little water required, but also on account of the smaller standby charges and the quickness with which the tool

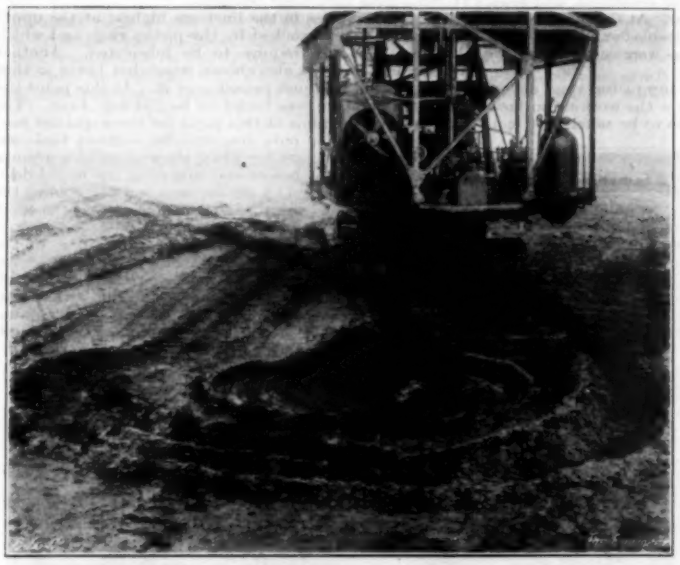


FIG. 1—REAR VIEW OF EXCAVATOR SHOWING TURNING TRACKS

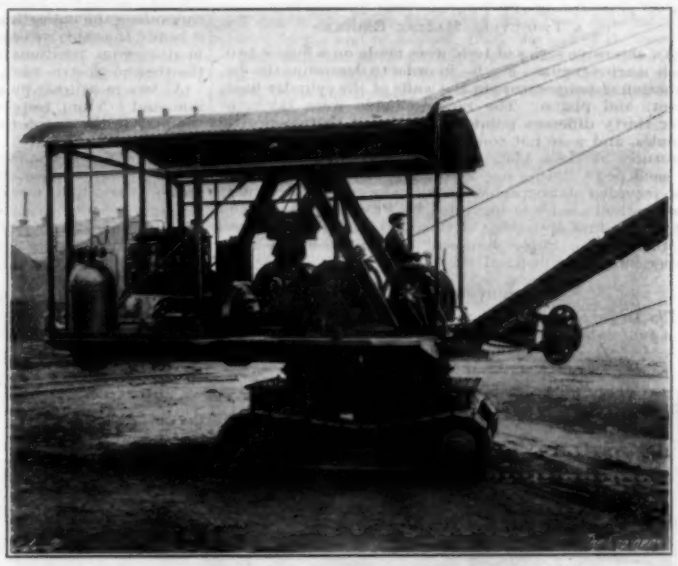


FIG. 2—SIDE VIEW OF OPERATING PLATFORM

can be put to work and then shut down when a given piece of excavation work is completed.

The general design of the new machine is illustrated in the accompanying engravings. It will be seen that as regards many of the constructional details the firm's standard design has been adhered to. Caterpillar propulsion has been retained with all its attendant advantages of easy travelling over rough or broken ground, and general flexibility of movement. The remarkably short turning base which is obtained by the independent control of the two tracks is illustrated by the photograph of the tracks reproduced in Fig. 1. Referring to the drawing on page 418, the centre plan and elevation views show clearly the arrangement of the travelling mechanism which is designed for two speeds, one of three-quarters and the other one and a-half mile per hour respectively. The bottom fixed frame is stiffly built up of steel plates and angles and is mounted on the two caterpillar tracks which are arranged for either common or independent operation. On the top of the frame there is carried a 6ft. 6in. diameter roller path with twenty-four 7in. diameter rollers which support the main bed-plate and the revolving frame carrying the hoisting, slewing and racking gears. The two main girders of the revolving frame are carried to the tail of the machine and form a support for the main oil engine bed-plate. Side supports are run out to the edge of the platform and floor space is thus given for the auxiliary engine, the starting air receiver, the cooling water radiator, and the driving controls.

The power required for travelling—which is sufficient for a gradient of 1 in 8—is transmitted to the vertical centre shaft by a horizontal cross shaft upon which the two driving pinions with their respective clutches are mounted. The pinions engage with a double crown wheel fixed at the top of the vertical shaft which passes through the centre post. Another bevel wheel at the bottom of the same shaft transmits the driving power to a cross shaft, placed below the main fixed frame, which carries a small spur wheel. This spur wheel meshes with another gear on the chain pinion cross shaft arranged parallel to the first shaft. As shown in the plan on the opposite page, the motion is transmitted by a heavy chain to the driving axle which carries the track sprockets.

At the other end of the frame is the axle with the track end-rollers. It is fitted with an adjusting arrangement for altering the tension in the tracks and taking up wear. Between the sprockets and the end rollers are the six track supporting rollers, which are so arranged that any roller can be dismantled without having to jack up the machine. Each of the tracks is furnished with a stop pin which engages a centre slot in the track, enabling either track to be declutched and held stationary when so required.

Power is supplied to the various motion gears by a three-cylinder Ruston cold-starting engine with airless fuel injection. The engine is designed for a normal output of 45 brake horse-power when running at a speed of 450 revolutions per minute, a twelve-hour load being assumed. On test, however, the unit was run at a load 10 per cent. in excess of the normal rating, so that it is capable of developing 50 brake horse-power for short periods. It is a standardised unit, totally enclosed and fitted with forced lubrication. An automatic self-starter working with compressed air is included in the equipment and a large air receiver which may be charged from an auxiliary oil engine-driven air compressor is supplied. The speed of the engine is controlled by a centrifugal governor, but it may also be controlled by hand. It will be seen from the illustration Fig. 2 that each cylinder of the engine is fitted with an independent exhaust pipe which is carried upwards and terminates just above the roof. This arrangement is both convenient and useful, and it permitted us to note the very even loading of each of the three cylinders which was given by the distributor system of oil fuel supply recently introduced by the firm. Other engine auxiliaries include a 50-gallon fuel oil tank and duplicate fan-cooled radiators for the circulating water. The main water-circulating pump is engine driven, while the cooler fans are chain-driven. An air whistle is attached to the starting air reservoir.

The main motions of the excavator may be followed from the drawings and sections reproduced on the opposite page and in Fig. 2. The clutch is built into the engine fly-wheel and is of the single dry plate type fitted with "Ferodo" friction surfaces which are also used on other parts of the mechanism. A bevel and spur main drive which also serves as the reversing gear is employed. The wheels on the main drive are enclosed in an oil bath.

The drums, both for hoisting and dragging, are driven by means of spur gearing—see plan view in the drawing—and outside band type clutches are fitted. They are operated by means of toggle gears. Brakes of the band type, which are pedal controlled, are fitted to both drums. The hoisting rope is $^{9}/_{16}$in. diameter and about 150ft. long, and is designed for a hoisting speed of about 127ft. per minute. A $\frac{3}{4}$in. diameter drag rope is used, which is designed for a dragging speed of 117ft. per minute, both ropes being of flattened strand construction.

The power for slewing is transmitted from the main drive to the reversing clutches of the double cone type. They are shown in section on page 418 at the top right-hand corner. Bevel gears transmit the driving motion to the slewing ring, which is fixed on to the bottom frame. The clutches are so designed that they are capable of easy adjustment and the friction linings can be quickly renewed when required. Adjustment is obtained by screwing up one of the male cones so that the distance between the two cones is sufficiently reduced to take up any wear on the friction lining. The clutches are operated by a quick pitch screw, the rotation of which either pushes or pulls the shaft and its driving clutches according to the direction of rotation required. A universal joint is fitted between the operating screw and the clutch shaft. The gears are designed to give a slewing speed of three and a-quarter revolutions per minute.

A sliding wheel engaging with the spur wheel on the slewing motion shaft serves to drive the derricking motion, the rope drum of which motion is driven by a worm and wheel. A brake is also fitted to this motion. The derricking rope is $\frac{3}{4}$in. diameter with a length of about 184ft. of $^{6}/_{37}$ construction. A tipping rope of flattened strand construction, $^{9}/_{16}$in. diameter and about 16ft. long, is provided.

All the control levers are grouped at the left-hand side of the machine near the front end of the revolving frame—see Fig. 2—so that the driver has an uninterrupted view of all operations. In the tests we witnessed on the firm's ground at Lincoln the machine answered quickly to all controls and the various operations were neatly carried out. The excavator has a designed capacity of 600 tons per day of ten hours in, say, average material.

Some reference may be made to the jib and bucket gear. The jib is built up of structural sections of lattice design, giving a light yet exceptionally strong member. It is carried by an A frame of rolled steel channels which is connected to the front of the bed-plate and to the side members of the machine at the rear. The pulleys at the head are machine grooved and bushed and the length of the jib between the centres of the jib foot pin and the pin at the jib head is 35ft. The fairlead at the bottom of the jib, which is shown in Fig. 2, comprises two short horizontally-placed pulleys which are mounted on a steel casting bolted to the jib, whilst a swivelling block with two vertical pulleys is pivcted to the main fairlead casting. The design is such that, as the bucket is being drawn in, if it be diverted from the direct path, the pulleys follow the rope and allow it to work in a good position. The swivelling casting is provided with renewable rope guards.

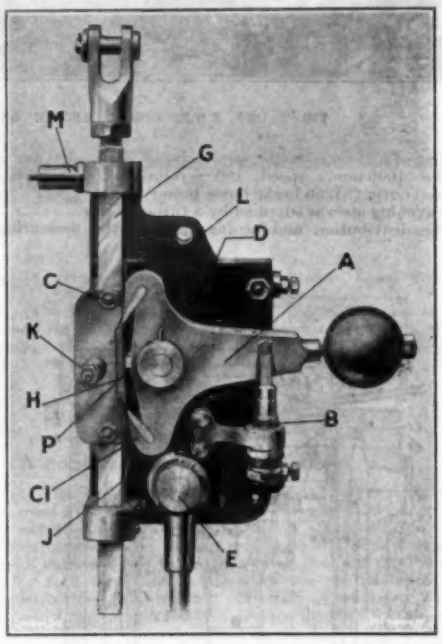
The type of bucket employed is shown in the drawing. It is constructed of steel throughout and a renewable lip plate is fitted. Cast steel trunnion brackets are used and two holes are provided for the drag chain connections so that the "bite" of the bucket can be varied at will by using the upper or the lower hole as the work demands. The capacity of the bucket shown is about three-quarters of a cubic yard.

A New Inertia Governor.

A FORM of governor, primarily intended for controlling marine internal-combustion engines, which is being made by Ramsay, Jackson and Co., Ltd., of 11, Queen Victoria-street, London, E.C.4, and which depends for its action on a rather peculiar mechanism, is illustrated by the engraving below.

The governor is of the direct-acting type, and may be used to operate any of the engine controls by means of the square rod G—seen on the left in the illustration. A connection is made with any convenient moving part of the engine, by means of the rod E, so that the plate D is given a reciprocating movement. On this plate there is pivoted the "escapement" lever A, the rocking action of which is restrained by a spring in the cap B. The lever, it will be seen, is furnished with two sharp, hard steel claws C and C1, which co-operate with the pawl H. This pawl is pivoted to the control rod at K with a spring washer giving just enough pressure to prevent the pawl from being moved accidentally. There is also another leaf spring J, fixed to the frame work, which holds the lower end of the pawl out when the control bar is in the lower position. A spring button in the cap M engages with either one of two slight depressions in the control bar at the two limits of its travel and holds it sufficiently firmly to meet vibration troubles.

The action of the governor is as follows:—At normal



THE RAMSAY-JACKSON ENGINE GOVERNOR

speed, or less than normal, the inertia of the weight on the escapement lever is almost balanced by the spring in the cap B. The top claw C is then tilted towards the bar G, but, in the position illustrated, it cannot catch the pawl H, as the spring J keeps the upper end in. At this speed the lower claw C 1 also clears the pawl on account of the strength of the spring in the cap B. The result is that the rod G remains in the lower position and the engine controls are left in the open position. If, however, the engine speed rises above the normal, the spring in B is not strong enough to overcome the inertia of the escapement weight and, on the up stroke, the claw C 1 catches the pawl H, so that the rod G is lifted and the engine controls are shut off. As the engine speed returns to the normal

the claw C 1 ceases to engage the lower end of the pawl, and as the lever A passes downward in front of the pawl, the projection P strikes the pawl and tilts its top edge outwards. The claw C can then engage on the next down stroke, and return the control rod to the open position again.

These governors are made in three standard sizes, with control strokes of 2in., 3in. and 4in. respectively, and have the merit of being very positive in their action.

Temperature Variation and Heat Stresses in Diesel Engines.*

By ROBERT SULZER.

(*Concluded from page* 392)

Measurements of the Temperature in the Walls of a Two-cycle Marine Engine.

An extensive series of tests were made on a Sulzer two-cycle marine engine—Fig. 9—in order to determine the distribution of temperature in the walls of the cylinder liner, cover, and piston. The measurements were taken at over thirty different points by means of thermo-electric couples, and were not confined to getting the mean temperatures at these places, the variation in temperature at each point during one revolution of the engine being also recorded photographically with the greatest accuracy. The method used was suggested by Professor Nägel, who set up the first apparatus of this kind in the laboratories of the Dresden Polytechnic and kindly placed his great experience at our disposal.

Method of Testing.

The Diesel Engine.—The tests were made in one cylinder of a four-cylinder two-cycle marine engine, with the following dimensions and particulars:—Bore, 600 mm.; stroke, 1060 mm.; speed, 100 revolutions per minute; normal output, 1350 brake horse-power.

Scavening air was supplied by a turbo-blower.

The distribution and arrangement of the measuring points can be seen from Fig. 11. The points on the inner side—gas side—are indicated by Roman numerals; they all lie 0·5 mm. under the surface which is in contact with the gases.

For the thermo-electric elements, copper and constantan wires 0·5 mm. in diameter were used, a temperature difference of 100 deg. Cent. at the junction giving about 5 millivolts. Accurate calibration curves were, of course, obtained. The thermo-electric wires for the principal measuring points were inserted in conically ground pins of grey cast iron in such a way that the wires, which were embedded in plaster of Paris in glass tubes, were led in two neighbouring holes 2 mm. in diameter to within 0·5 mm. of the outer surface. In the last half-millimetre of the wall thickness the wires were carefully riveted to the cast iron pins, so that the electric connection was made exactly at a depth of 0·5 mm.; the current enters and leaves the cast iron at points of equal temperature, so that the insertion of cast iron into the circuit does not affect the measurements of the temperature.

The measuring points in the piston necessitated the cable leading to the instrument bench being particularly carefully arranged. The individual wires were led from the piston cooling-space in a water-tight manner, and led out of the engine in a cable of twenty-four wires, each of which was insulated in a rubber tube—bicycle valve tubing—along the piston-rod to the crosshead, and from there along the indicating gear lever. At the points where it bends, the cable was carried in suitable flexible supports; in dangerous positions steel wires were substituted for the thermo-electric wires.

At two measuring points in the top piston ring, at 0·5 mm. and 1·5 mm. respectively below the working surface, the play in the piston ring had also to be taken into consideration.

The thermo-electric wires from piston, cylinder cover, and liner were connected to three-way switches on an instrument bench, by means of which they could be switched for approximate measurements to a millivoltmeter, or for exact measurements of the mean temperature to a compensating connection, or finally for obtaining photographic diagrams of the temperature variations to a thread galvanometer.

The apparatus for photographing the temperature variations—see Fig. 10—was set up in a separate room some distance from the engine in order to be as free as possible from vibration; the thread galvanometer recording the variations in the thermo-electric current was hung on steel wires so as to be perfectly free from any vibration. The thermo-electric current flows through a gold thread about 100 mm. long and about $^1/_{200}$ mm. diameter, stretched between the two strong magnetic poles of the instrument. By means of an arc lamp and microscope the shadow of the gold thread was observed and its sag, corresponding to the strength of current, recorded photographically on a revolving drum. The drum was turned by an electric motor fitted with adjustable speed regulation, and was lighted through a small axial slit closed by a shutter which was opened when required during one revolution of the drum.

A spark gap, actuated by an exciter, recorded on the sensitised paper the position of the crank of the engine by means of a contact disc attached to the brake end of the crank shaft. The following points were thus recorded at the edge of the paper:—Upper dead centre; 60 deg. expansion; 120 deg.; lower dead centre; 90 deg. compression; upper dead centre.

By means of a differential connection it was arranged that all the thermo-electric current did not pass through the gold thread in the galvanometer, but only the amount corresponding to the variation in temperature above or below the mean temperature. The maximum strength of current in the instrument amounted in general to only $\pm\ ^4/_{1000}$ milliampère.

A calibrating connection made it possible, as each photograph was taken, to record on the paper the positions of the gold thread corresponding to certain strengths of current by means of adjustable wire marks.

Results of the Tests.

Drawing Fig. 12 gives a general idea of the temperature distribution found by the above-described method in the combustion space, with the engine running under full load at 100 revolutions per minute. The isothermal lines which have been sketched in show the heat flow to the cooling water.

The highest temperatures in the cylinder cover and also in the piston reach 300 deg. Cent., in round figures.

At the top of the liner, at a spot not reached by the piston ring, a temperature of 333 deg. Cent. was recorded, and is the highest reading obtained in the walls at full load.

The temperatures in the piston head show clearly the effect of the central injection of fuel with cold air and the gradual starting of the combustion. The centre of the piston head always remains the coldest part. At small loads the temperatures are highest halfway between the centre and the edge of the piston; whilst at full load, when the combustion lasts longer, they are highest at the edge. Similarly the upper part of the liner does not come under the influence of the burning gases until the engine is heavily loaded.

By means of the temperature variations during a cycle of operations, this course of combustion deduced from the distribution of the mean temperature was also confirmed. The variations are least at the centre of the piston head. The temperature diagrams given in Figs. 13 and 14 show the variation in temperature during two revolutions of the crank shaft at half load and at 100 revolutions per minute—Fig. 13—for the centre of the piston head; and Fig. 14 halfway between the centre and the outer edge. The original diagrams, which measure 170 × 280 mm.—6·7 × 11·0in.—give very clear readings.

The temperatures in the liner are highest at the upper part, which is not reached by the piston ring, and which therefore does not require to be lubricated. Another measuring point was also chosen somewhat lower so that the top piston ring just passed over it. At this point the mean temperature was found to be 251 deg. Cent. The temperature diagrams at this point for three-quarter load—Fig. 15—and for pure compression, without fuel—see Fig. 16—are interesting. They show a sudden change of temperature just before and just after the upper dead point, a change caused by the upper piston ring cooling the liner when passing over it, to such an extent that the effect is perceptible even $\frac{1}{2}$ mm. below the surface.

The piston ring therefore cools the upper part of the cylinder liner. The temperature of the top ring must, therefore, be considerably less than 250 deg. Cent. at full load; in fact, measurements made in the ring at full load gave a mean temperature of 128 deg. Cent. and a maximum value of 135 deg. Cent. *In a two cycle marine engine, therefore, the temperatures attained by the piston rings are far lower than the temperatures in a steam-engine cylinder fitted with a steam jacket.* This should dispose of the idea that the high temperatures in a two-cycle engine will lead to difficulties with regard to lubrication.

The temperature diagram—Fig. 17—shows the variations in temperature in the piston ring at three-quarter load during two revolutions; it is also measured at a point lying 0·5 mm. under the working surface. The variations, which may at first sight appear incomprehensible, can be explained as follows:—

Shortly before the upper dead point the piston ring passes on to the hottest part of the liner, the top part, and is quickly warmed up by about 10 deg. Cent.; then—at the same distance after the upper dead centre—it passes again to the cooler part of the liner and consequently begins to cool But before the lower dead point is reached, the piston ring with its measuring point passes in front of an exhaust port. The cooling effect of the cold wall is

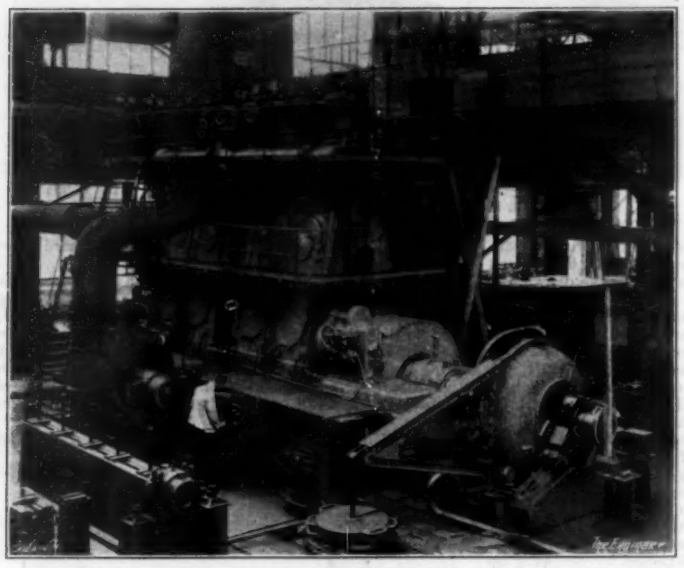


FIG. 9—1350 B.H.P. DIESEL ENGINE ON TEST BED

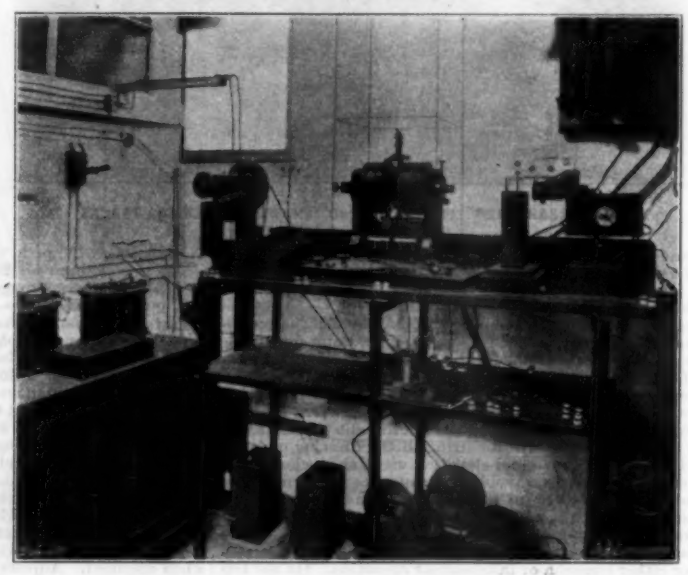


FIG. 10—VIEW IN THE GALVANOMETER ROOM

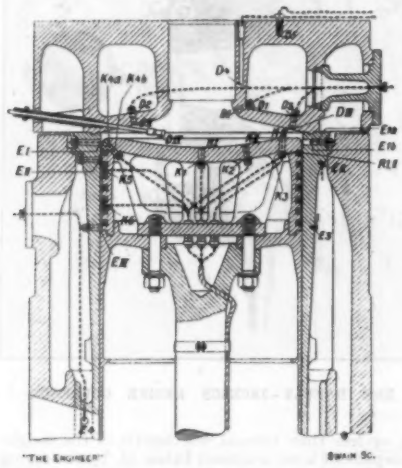


FIG. 11—TEMPERATURE MEASURING POINTS

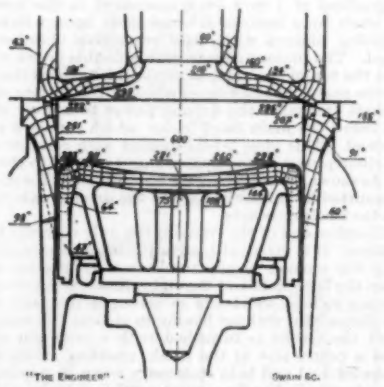


FIG. 12—TEMPERATURE DISTRIBUTION

* Paper read before the Institution of Naval Architects on Thursday, March 25th.

suddenly interrupted, and heat passes from the hot interior of the ring into the previously cooled outer surface. The temperature rises by a corresponding amount, at first quickly and then slowly, until the piston on the return stroke, just as far from the lower dead point, closes the exhaust ports and the measuring point again comes into contact with the cold wall of the liner. Shortly before reaching the exhaust ports a small kick is shown in the falling curve when passing a lubricating hole in the liner.

That cooling, in fact, takes place only in the outer layer of the ring is shown by the diagram given in Fig. 18, which shows the variation of temperature in the piston ring at a spot 1·5 mm. below the working surface. The two diagrams given in Figs. 17 and 18 were taken one immediately after the other, and the two measuring points were only a few millimetres apart, so that the difference between the diagrams can only be attributed to the difference of 1 mm. in depth of the two measuring points.

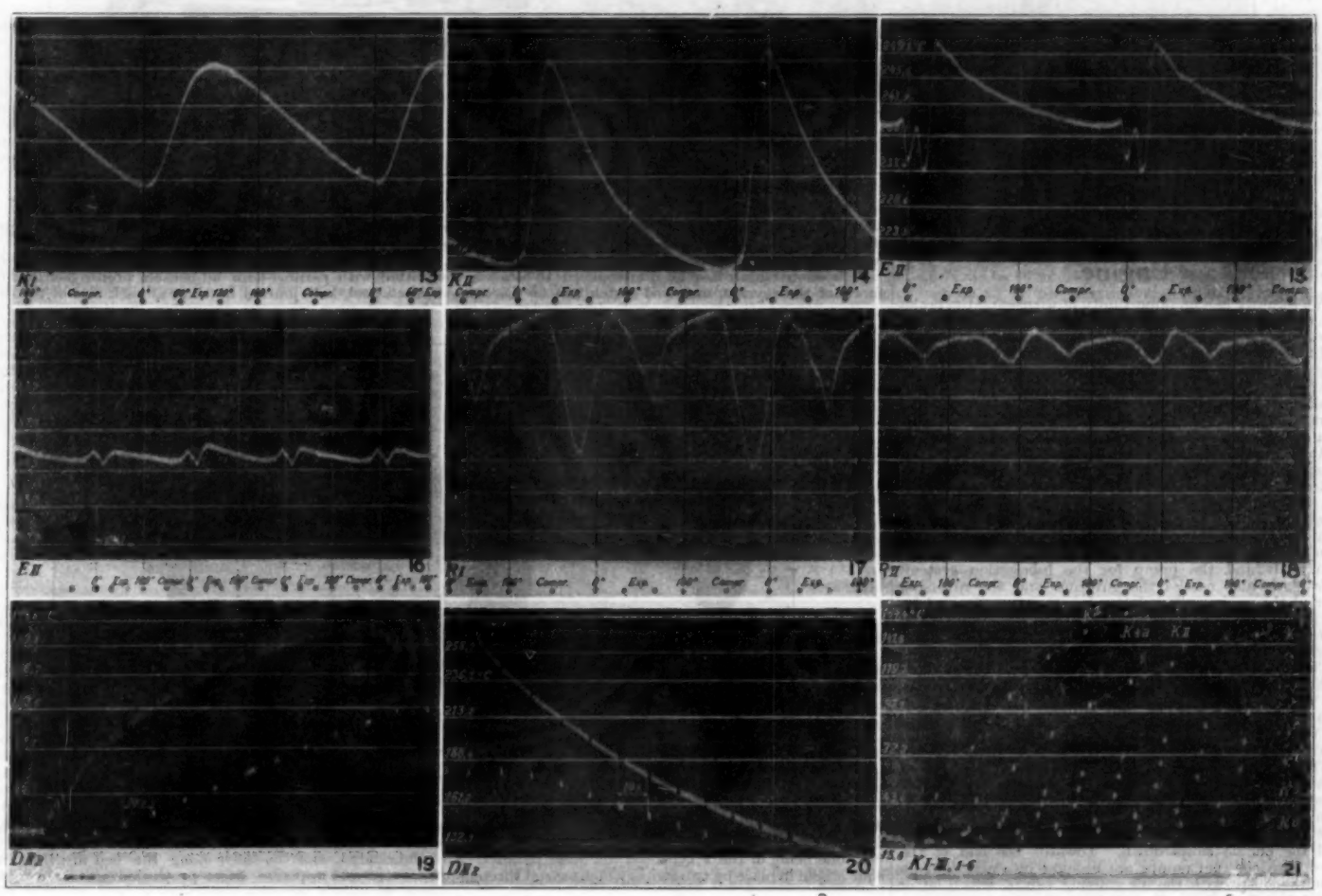
The temperature diagrams taken while starting and stopping are particularly interesting. The diagram given in Fig. 19 shows, for example, the rise of temperature at a measuring point in the cover when starting under full load—with the hydraulic brake filled.

Each ignition can be clearly seen. In order to give a time scale, the galvanometer was switched over every 10 seconds from the measuring point on the gas side to the corresponding one on the water side, so that the rise of temperature on both sides of the plate are given in the same diagram.

The diagram given in Fig. 20 shows the fall of temperature when suddenly stopping from full load. The last ignitions can be seen clearly, and immediately after the last one the temperature on the gas side falls sharply. On the water side there is no sign of any fall of temperature in the first ten seconds.

The last diagram—Fig. 21—shows the rise of temperature in the whole piston head during the first three minutes when starting from cold under full load. The ten measuring points were connected to the galvanometer one after the other, each for 2 seconds, so that the temperature at any one point is shown at 20-second intervals.

In addition to the temperature diagrams for the walls, which were taken under various working conditions at different loads and speeds, and with different fuels, injection air pressures, scavenging air pressures, &c., a thermo-electric couple was also introduced into the combustion space at various depths, and temperature diagrams were taken by means of it in order to make a special investigation of the heat transmission. In all, about two hundred temperature diagrams were taken in addition to the usual records of fuel consumption, indicator diagrams, cooling-water, air and other necessary measurements.



TEMPERATURE VARIATION CHARTS

FIG. 13.—*Temperature Variation at Piston Head Centre, Half-load, 100 r.p.m.*

FIG. 14.—*Temperature Variation Half-way Between Centre and Edge of Piston Head, Half-load, 100 r.p.m.*

FIG. 15.—*Temperature Variation in Cylinder Liner, Three-quarters Load, 100 r.p.m.*

FIG. 16.—*Temperature Variation in Cylinder Liner, Compression (no fuel), 100 r.p.m.*

FIG. 17.—*Temperature Variation in Top Piston Ring, 0·5 mm., under the Rubbing Surface, Three-quarters Load, 100 r.p.m.*

FIG. 18.—*Temperature Variation in Top Piston Ring, 1·5 mm., under the Rubbing Surface, Three-quarters Load, 100 r.p.m.*

FIG. 19.—*Rise of Temperature in Cylinder Cover, Starting under Full Load.*

FIG. 20.—*Fall of Temperature in Cylinder Cover, Stopping from Full Load.*

FIG. 21.—*Starting-up Temperature Rise at Various Points in the Piston Head, 20 Second Readings.*

A NEW Strowger automatic telephone exchange at Ipswich is ready for service.

South African Engineering Notes.

Important Ship Repair.

The South African Ironworks, Cape Town, completed in December last an important repair contract for the steamship City of Athens. This steamer lost her propeller tail shaft some hundreds of miles from port, but her S.O.S. calls brought another steamer, belonging to the same line, to her assistance, and she was towed to Cape Town, and, after discharging cargo, dry-docked. The vessel was four weeks in the hands of the repairers, during which time much complicated work was accomplished. A new stern tube, weighing 4 tons 12 cwt., was put in, and a new tail end shaft weighing 9½ tons fitted in the tube, while a propeller weighing 14 tons was shipped on the shaft. All these heavy weights had to be handled with the ship's and contractors' gears, the dry dock being bare of equipment. Amongst other things, two lengths of tunnel shafting had to be taken out of the ship, to the contractors' shop and turned up in the lathe. Before proceeding to sea the steamer ran a four hours' trial steaming full speed for nearly two hours. During the trial the engines came to within three revolutions of the speed attained on her maiden trial trip, there being no stop and no hot journals.

Union Railways' Traffic.

The report of the general manager of the South African Railways and Harbours for the year ended March 31st, 1925, shows that a remarkable expansion of traffic took place. The total tonnage of goods and mineral traffic conveyed, including departmental requirements, was 22,817,060. No greater tonnage had been moved in any one year by the railways. In comparison with the year 1909—the last before Union—the figure represents an increase of 12,548,000 tons, or 122·21 per cent. The tonnage of revenue-earning coal, viz., 9,736,403 tons, constituted a record. Compared with 1923–24 and the calendar year 1909, the tonnage conveyed was greater by 302,784 tons and 4,539,029 tons respectively. The number of passengers carried was 70,832,189, representing an increase of 5,020,000, or 7·63 per cent. over 1923–24, when the previous record was established. At the harbours the tonnage of cargo handled was 7,138,829, an amount never previously exceeded. Compared with the calendar year 1909 there was an increase of 78·15 per cent. The gross tonnage of shipping which called at the ports was 22,751,552, representing another record, and exceeding that dealt with in 1909 by 59·08 per cent. Having discussed the great crops of maize, fruit, cotton, &c., obtained during the year, and the almost certain further large expansion to be experienced in the following year, the report describes the steps which have been taken to utilise engines over long continuous runs with a view to obtaining, for economic reasons, the maximum use out of the locomotive power.

The introduction of the "Mountain" and "Pacific"—now called here "Karroo"—types of engines has met with such success that orders have since been placed for a considerable number more, for use where the topography of the country and operating conditions permit of long-distance running. With regard to the electrification of 175 miles of railway in Natal, it is stated that the electric locomotives are doing the work expected of them, and no difficulty has been experienced in handling the loads specified. The total earnings were £21,747,631. Gross working expenditure, including depreciation, relaying and strengthening, £16,858,571. Surplus of earnings over gross working expenditure, £4,889,060. Interest on capital £4,147,882. Net surplus—after including miscellaneous receipts and charges—£820,925. The total earnings of the harbours were £1,375,045, and the net surplus, after deducing gross working expenditure, depreciation, expenditure on lighthouses, and including miscellaneous receipts and charges, was £368,764. The accumulated deficit at March 31st, 1925, had been reduced to £5185. At the end of August, 1925, the last of the accumulated deficit had been liquidated and a surplus of £87,279, was in hand. The open mileage in the year was 11,528, while the mileage worked by the Administration, which included the lines in South-West Africa, was 12,162 miles.

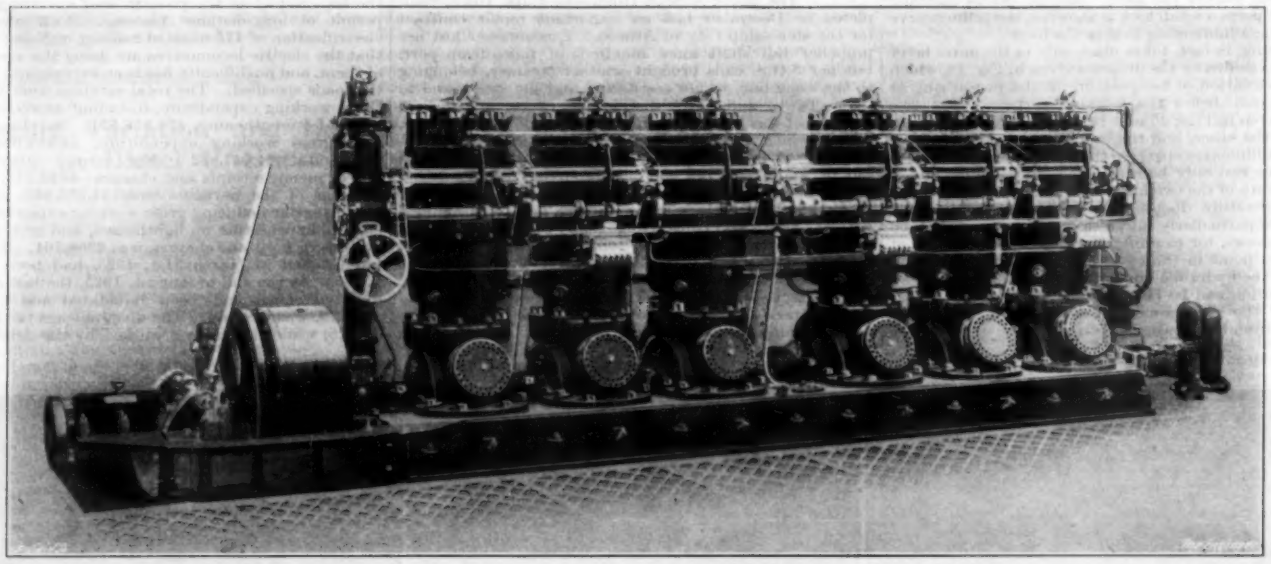
A Briquette Manufacturing Company.

In view of the enormous quantity of serviceable and even high-class coal that goes to waste as fines, or in the selective process that prevails in the coal industry of this country, and having regard to the high average cost of domestic fuel to the consumer, it is not at all surprising that a scheme is afoot for the manufacture of briquettes from this rejected material. A company with a nominal capital of £150,000, divided into 600,000 shares of 5s. each, has been registered in the Union for objects which are more particularly specified as follows:—"To acquire from the vendor his rights in and to certain formulæ for the manufacture of briquettes and colloidal fuel, and to manufacture briquettes and colloidal fuel for household and steam purposes; to provide retorts for carbonising and extracting the by-products, and to acquire coal properties for the supply of raw material required by the company." In addition to the production of fuel in the shape of briquettes by means of a low temperature process, it is proposed to manufacture and sell the accompanying by-products. The name of the undertaking is "The Briquette and Patent Fuel Manufacturers of Africa, Ltd."

A BY-PRODUCT coking plant, of 35 ovens, is to be put up at Hamilton, Ontario, in extension of the existing works. The capacity will be 1000 tons a day.

300 B.H.P. OIL ENGINE FOR YACHT PROPULSION

L. GARDNER AND SONS, LTD., PATRICROFT, ENGINEERS



300 B.H.P. Six-Cylinder Heavy Oil Engine.

We recently had an opportunity of witnessing the brake test of a six-cylinder heavy oil engine of 300 brake horse-power, one of a pair which have been built by L. Gardner and Sons, Ltd., Patricroft, Manchester, for a private twin-screw yacht. This is the largest engine of the type that this firm has constructed, and it has cylinders 13½in. by 15in. stroke. It is of the two-cycle hot-bulb pattern. The admission of the air charge to the cylinder and the expulsion of the products of combustion are effected by ports in the cylinder wall, these ports being covered and uncovered by the piston in the course of its travel. The features of the Gardner engine, including the engine bed, the crank cases, the lubrication systems, the cylinder breech and the dome, are familiar to our readers, but we may say that the vertical countershaft is driven through helical gears from the crank shaft and serves to drive the cam shaft and the pump for the lubrication system. This shaft also carries the governor and the reversing gear of the engine. This latter function is performed by the gear on the vertical shaft, which is capable of a sliding motion along the shaft. The same device regulates the time of ignition or injection of the fuel.

The present engine is fitted with a special governing device. The air compressor, circulation and bilge pumps are all neatly arranged at one end of the engine bed. The compressor is water jacketed and is driven direct by the main crank shaft, and the two pumps are also driven by cranks on the main crank shaft.

The complete operation of reversing the direction of rotation of the engine is performed by four turns of a hand wheel, by which means the angular position of the cam shaft is changed from "ahead" to "astern." The first turn of the wheel puts the fuel pumps out of action and the engine slows down. Towards the end of the third turn the fuel pumps are brought into action again simultaneously with the air starting valves, which latter admit a puff of compressed air into the cylinders, causing the engine to start running in the reverse direction. At the end of the fourth and last turn of the wheel the air valves are put out of action, and the engine now runs under full conditions in the desired direction. The above operation is completed in about three seconds.

When we saw the engine running under full load against the brake the revolutions were 290 per minute, and the fuel consumption never exceeded ·445 pint per brake horse-power per hour. The fuel in use was Shell gas oil of ·858 specific gravity. The speed was under admirable control by the governor gear, and the engine ran sweetly and quietly.

Portable Internal Grinding Attachment for Heavy Lathes.

The grinding attachment illustrated in Figs. 1 and 2 herewith has been built by Herbert Hunt and Sons, Old Trafford, Manchester, and is intended for operation on large pieces of work which have been rough-turned on the lathe, and can be ground without the necessity of resetting, or where a large internal grinding machine is not available for the work. The appliance is designed to fit on to the lathe tool post, and is bolted on the swivel slide. It has a self-contained drive, and is arranged to give a maximum self-acting traverse of 2ft. along its bed. Power is supplied by a 5 horse-power variable-speed electric motor, mounted on the frame. The grinding wheel is 14in. diameter, with a 2in. face, and can be used down to a diameter of 8½in. The drive from the electric motor to the drum pulley on the grinding spindle is by means of a 3½in. belt, which is kept in tension by means of a weighted jockey pulley.

The traverse slide carrying the spindle is self-acting, and has three ranges of speed, the changes being made by means of a hand lever. Provision is also made, by means of change wheels, for an extended range of traverse speeds to suit the greatly varying diameters of the work. The traverse motion consists of the usual bevel gears, clutches and rack and pinion.

A friction clutch has been introduced to deaden the shock of the reverse, and this clutch can be disengaged when the slide is traversed by the hand wheel. The faces of the traverse slide are formed to fit those of the bed, one being of the V type and the other parallel. The slide is held in place by two strips, which extend throughout its whole length. Automatic lubrication is supplied by means of oil rings. The base of the attachment can, of course, be built to suit any existing design of lathe saddle, the slide of which has a rapid cross-traverse motion. Provision can also be made for a cross slide with fine adjustment. This is not shown in the half-tone engraving.

The grinding wheel spindle, which is 2in. diameter, is fitted with parallel-bore adjustable bronze bearings near the wheel, ball journal bearings at each side of the drum pulley and a double ball thrust at the extreme end of the spindle. All the bearings are dust-proof and well lubricated, and the slides along the bed are fitted with covers and wipers. Steel protection guards are fitted to the grinding wheel as well as to the gearing.

The machine is also built for external work from the same pattern with a slight modification of the grinding head, which is arranged so as not to overhang the slide.

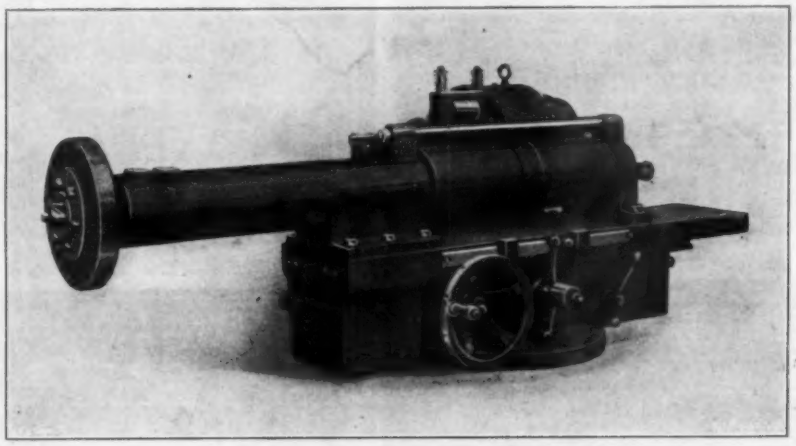


FIG. 1—INTERNAL GRINDING ATTACHMENT FOR HEAVY LATHES

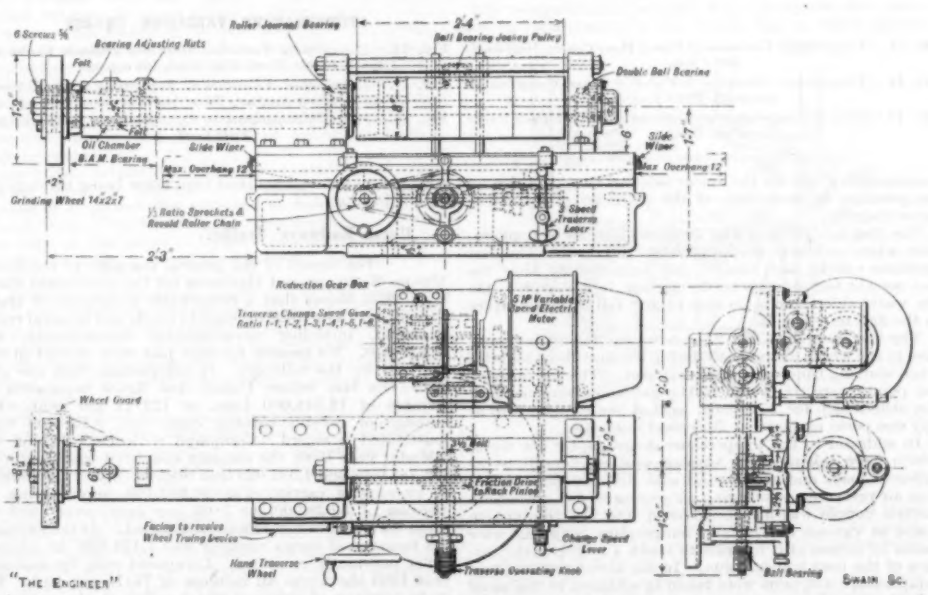


FIG. 2—ARRANGEMENT OF GRINDING ATTACHMENT

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Easter Holidays.

THE business transacted at the weekly meeting of the Midland iron and steel trade in Birmingham to-day —Thursday—was insignificant. The attendance of ironmasters and merchants was exceptionally small. Most of the works in the district are taking a full week's holiday for Easter. There are important exceptions, however, the larger works in particular having fairly good order books. Where pressure did not necessitate recommencement, the opportunity was taken to carry through repairs, and generally to get the works into condition for the brisker period which it is hoped will follow the coal settlement. At the moment the outlook is obscure, and trade this week is too stagnant for market quotations to have very much significance. So far as they were tested, values have changed very little on the week in the main categories. All eyes are now turned to next week's quarterly meeting, for from it will be gathered the probable trend of trade in iron and steel for the next three months. The apathetic tone which now prevails does not promise any great accession of new business. At all the stages of production there is a strong disinclination to risk anything, and producers in this area are not expecting over much from the meeting. It is anticipated that there will be a very large attendance of representatives present from all parts of the country, and opportunities will be taken to exchange views as to the probability of getting over the difficulties in the coal and engineering industries without interruption of industrial activities.

Relentless Economy Needed.

That the British iron and steel industry has suffered a severe setback compared with 1924 is the opinion of Mr. G. Hatton, chairman of the Midland Iron and Steel Wages Board, but he also holds that there are signs that the corner has been turned, and that in 1926 some advance along the path of industrial recovery may be made. Courage and faith are needed, he says, and they must be accompanied by relentless economy in every branch of the industry, with no shirking, either at the top or the bottom. It was only by the utmost effort and vigilance on the part of all that they could hope in a world of fierce competition to survive and keep the standards of life so far in advance of those of European competitors.

Staffordshire Wrought Iron.

The finished iron department of the Midland market is extremely quiet. It is only marked bars that fully maintain the basis rate—£14. In medium and common grades there is a certain amount of price irregularity. Demand shows no material change, but the tone is more hopeful, and the vigorous propaganda carried on by ironmasters for the information of shipbuilders, boilermakers, engineers, &c., as to the undoubted merits of Staffordshire iron, compared with cheap Belgian material, is believed to have had a good effect. Mr. George Hatton, the chairman of the Midland Iron and Steel Wages Board, realises that the displacement of the cheaper grades of wrought iron by foreign material is a serious matter, and he is of opinion that serious emphasis ought to be given, through the instrumentality of the Board, to the fact that Belgian and other cheap continental so-called wrought iron—which contains so very large a percentage of steel scrap—is a material more highly susceptible to corrosion than genuine wrought iron. Consumers should understand that it did not follow in the least that a cheap first cost necessarily gave an economical final result. He ventured to say the contrary was the case. The ironmasters had been very active in propaganda work. Some good results had followed, for all the railway companies had now specified that British-made material should be used for their requirements in wrought iron and its manufactures. The exports of wrought iron in 1925 were 37,057 tons, and the imports 231,752 tons.

Ironworkers' Wages Reduced.

For the fifth time in succession, the bi-monthly ascertainment of wages under the sliding scale of the Midland Iron and Steel Wages Board results in a fall in ironworkers' wages. There have been four reductions of 2½ per cent. each, followed this month by one of 5 per cent., bringing the basis rate for puddlers to 50 per cent. above the basis of 13s. 6d. per ton. The award is operative as from Monday last until June 5th, and as the purchase price of iron and steel still tends downwards, further wage reductions must be expected in the future.

Pig Iron.

The general disposition in the pig iron department is to stand still; and with a few sales affected the tendency is for prices to weaken, though nominally, recent quotations are maintained. Pig iron contracts which have expired with March are not being renewed. Forgemen and foundrymen prefer to satisfy their requirements as they arise, keeping as close as possible to current fluctuations. In neither branch is there much sign of vitality. Production has been suspended at most of the local ironworks during the week, and stocks at blast-furnaces, which smelters have been striving to keep down to the minimum, have necessarily been augmented. The one most anxious for business at the moment is the smelter and not the consumer, and though Derbyshire No. 3 foundry is quoted £3 6s. to £3 6s. 6d., forge £3, Northamptonshire foundry £3 3s. 6d., and forge £2 15s. to £2 16s., it is thought sellers would be prepared to accept less in the event of fairly large tonnages being contracted for.

Steel.

Industrialists in the Midlands look upon the decision of the Steel Association to restore price agreements as a sign of increasing confidence. A section of the trade would have been well satisfied to allow the market to take its own course for a time; but the decision has given most manufacturers considerable satisfaction. The trade is, on the whole, more promising, and business secured at fixed rates should allow of a fair percentage of profit, whereas much of that recently executed has yielded no return. The movement starts with reasonable hope of success, mainly because the only step taken so far is the stabilisation of prices which have been in operation for some time. The minimum for ship, bridge and tank plates in this district is, as I remarked last week, £7 15s., but the items of more interest to the Midlands and Staffordshire are those of joists and sections, for which £7 has been adopted. Sales have been made within the last month at 2s. 6d. above this figure, and the conservative attitude of the Association is indicated by the adoption of £7, which is practically the bottom price. There is little alteration in values of other classes of steel. Demand has been so quiet over the past fortnight that the market level has not been tested. Small bars make about £7 15s., Staffordshire hoops £10 10s. at works, boiler plates £11. Bedstead angles, however, are down 2s. 6d. per ton, to £8 12s. 6d. Mild steel billets are a little firmer on the basis of £6 per ton. It is possible to buy Belgian billets at £5 7s. 6d. delivered, but France has none to offer, and the difference between the native and foreign price is scarcely attractive to the Staffordshire re-roller, when various disadvantages are taken into consideration. Foreign finished steel is still offered very cheaply, joists being obtainable at £6 5s. delivered in the district, or 15s. below the local figure. Plates can be bought at £6 11s. 6d., f.o.b. Antwerp, giving an advantage of about £1 over the price just fixed by the Steel Association. Foreign bars at £5 5s. 6d. are undoubtedly being sold in large quantities to Birmingham merchants, for shipment direct from Antwerp to foreign destinations.

Sheets Values.

Business in the galvanised sheet branch is not as brisk as it was, and orders are less easy to get. Mills which make a full output programme the first consideration are taking lower prices in order to get the turnover; £15 17s. 6d. is now pretty generally quoted for 24 gauge corrugated sheets, but this is not a rock-bottom price. On the other hand, there are makers who will not come below £16.

Steel Scrap.

Larger quantities of steel scrap continue to be sold, and as much as £3 8s. 9d. has been obtained by Birmingham sellers for delivery into South Wales, as compared with the recent figure of £3 7s. 6d.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

General Conditions.

NOMINALLY business after the Easter holidays was resumed on Tuesday, a day which, as a rule, so far as the iron and steel markets are concerned, is the busiest of the week on 'Change here. The process of settling down has, however, been a slow one, and with nothing much to discuss in the way of business on the opening day, most people seemed to be disposed to discuss in the light of the aftermath the events of the recess. At the time of writing nothing new in the direction of important business has presented itself, and it is regarded as improbable that anything big will be done whilst the wage problems of the coal and engineering industries remain unsolved. In the latter case the request of the trade unions for a county conference with the employers to consider the application of the men for an increase of £1 a week has been refused on the ground that the rules of the National Federation do not allow of a county conference to consider wages alone. The Manchester District Engineering Employers' Association has, however, arranged a local conference for Monday next to discuss the claim, and it is expected that conferences in other Lancashire areas will follow automatically.

Non-ferrous Metals.

In the market for non-ferrous metals prices are showing a steadier tone in most sections than has been the case for several weeks, although locally the volume of buying is no heavier than it has been. As regards tin the unwavering belief here that the statistical position of this metal is quite strong in spite of the heavy fall in values since the £300 mark was touched in the middle of last month, seems to be borne out by the estimates of a reduction of about 1800 tons in the visible supply. A pronounced recovery from the lowest point touched has been made, and the view is that the statistical position is likely to be favourable to a return of steady if not firmer prices. Copper has also displayed a stronger tone, although the outlook for the immediate future of this metal is rather uncertain, for the demand either in Europe or in the United States is by no means pressing. Spelter seems to command a fairly strong position at the moment as a result of the steps taken by American producers to reduce outputs. Lead has recovered some of the lost ground, and seems to be steadier just now than it has been recently.

Iron.

Users of pig iron up to now have shown little sign of departing from the policy of cautious buying that has been so marked a feature of this market for nearly three months. Although, of course, a certain amount of business is being done, the bulk of it seems to be of a hand-to-mouth character, and few important contract bookings have been reported. Some of the producers of pig iron are still engaged on orders placed in December and January, and there seems little inclination on their part to bring quotations down to a lower level. About 76s. per ton continues to be the price asked for Lincolnshire, Derbyshire and Staffordshire No. 3 foundry irons, including delivery into this district, in some cases quotations being down to about 1s. less than this. Both Scotch No. 3 and West Coast hematite are on offer at about 94s., delivered, and East Coast hematite at 76s. 6d. on rails. Forge iron is dull and prices are nominally unchanged at 72s. 6d. to 73. 6d. per ton delivered. The demand for bar iron is only very moderate, but quotations for Lancashire makes are well held at £11 10s. per ton for Crown bars and £10 5s. for second quality, including delivery in the South Lancashire district.

Steel.

The new fixed prices for steel joists and sections and for ship plates have been welcomed here as a means of putting an end to the price cutting which has been going on for some time, and—though this remains to be seen—by abolishing any inducement he may have had to hold off the market as long as possible in the hope of profiting by better offers, of persuading the buyer to place his orders freely as his requirements arose. Up to the present, at all events, the new control scheme has not created any increase in buying interest, although perhaps it is early yet to expect any development in that direction. In the meantime, steel bars are quoted at from £7 17s. 6d. to £8 5s. per ton, joists and sections at £7, and ship plates at £7 15s. delivered Manchester or equal distance. The Indian buying season for galvanised sheets is not expected to begin until some time in May, and for the time being business in these sheets is limited. Prices continue to display a weak tendency at £15 12s. 6d. per ton f.o.b., although a shilling or two less than this has been the basis of a recent small parcel placed here. At their present quotation galvanised sheets are at the lowest level touched throughout last year, but a recovery is looked for when the Indian season begins. As regards continental steels I do not hear of any important orders being placed. The values of virtually the whole range quoted on this market are weak and lower than those given in this column last week. Steel bars are at about £6 2s. 6d., joists and angles at £5 15s., Siemens plates at £6 14s., ordinary plates at £6 7s. 6d to £6 8s. 6d., ordinary billets at £5 4s., and sheet bars at £5 6s. per ton, delivered in Manchester, for cash against documents.

Scrap.

The demand for scrap metals, both iron and steel and non-ferrous, has been very quiet. Gun-metal scrap, best selected, is quoted at £52 to £53, aluminium, £90; brass rod turnings, £40; zinc, £25 10s.; lead, £30 to £31; heavy copper scrap at £61; and braziery copper at £48 to £49 per ton, for graded materials, delivered to consumers' works. Textile machinery scrap is quoted at from 72s. 6d. to 75s. per ton, ordinary machinery scrap at about 5s. per ton less, and wrought iron at 65s. delivered, with mild steel scrap quoted at about 55s. per ton on rails in Manchester.

Liverpool Engineering Society.

With the title, "Some Recent Work on the Corrosion of Metals," the paper contributed by Mr. Ulick R. Evans to the proceedings of the Liverpool Engineering Society, on Wednesday, 31st ult., contained much useful information on a subject the importance of which is still by no means appreciated even by engineers. In the paper the author confined his remarks very largely to the essential features of what he calls the newer electro-chemical view of corrosion. The paper was illustrated by a number of experiments, and special reference was made to the use of inhibitors, such as sodium carbonate, sodium silicate and potassium chromate. The author said that a solution of chromate in pure water inhibited corrosion efficiently, but that water containing both chromate and chloride might cause intense localised corrosion at points, and more particularly along the water line. Similarly drops of water containing both chromate and chloride placed on metal developed intense corrosion at certain points usually situated along the margin of the drop. Although the use of inhibitors was sometimes effective, they were by no means free from danger, and it was better, from the purely chemical point of view, to take away the dissolved oxygen by heating under slight pressure or by allowing the water to expend its corrosive power on some inexpensive form of iron, such as scrap or cheap perforated sheet.

Institution of Civil Engineers.

Before the Manchester and District Association of the Institution of Civil Engineers, a paper was read on Wednesday, 31st ult., by Mr. W. Hepworth, Assoc. M. Inst. C.E., on "Permanent Way Design on British Railways." The author said that at a very rough estimate the track of the British railways was worth no less than £150,000,000, and that a sum of £13,000,000 was spent annually on its maintenance. When once a standard design of track was adopted the engineer had not great scope for saving in first cost, but he would at least have the choice when considering the relaying of any section of line whether to use the heavier or lighter type of standard track, that was, the 95 lb. or the 85 lb., or, on less important lines, whether to use serviceable old material. It was now the custom for all lines of a railway to be graded according to the traffic they bore into first, second and third-class. Though, as a general rule, 95 lb., 85 lb. and serviceable old track would be used respectively in relaying these, it was often wise to make exceptions. It had always been an objective that the various parts of a track should have the same life, but in some cases, owing to traffic or atmospheric conditions, a considerable difference in the life of sleepers and rails must exist. An object in such cases might be to arrange that the life of one might be some multiple of the life of the other. For instance, on a certain line, classified as first on account of express trains running over it, the traffic on the whole might not be heavy and the atmosphere might be pure, and 95 lb. rails need not be used, as 85 lb. rails would last as long as two sets of sleepers. On the other hand, in a certain tunnel, it might be quite safe to depend upon a sleeper life of fourteen

years, whilst owing to loss by corrosion, two sets of 95 lb. rails might be necessary to last the same time.

Barrow-in-Furness.

Hematite.

Generally speaking, the trade in the North-West district in hematite pig iron is on the quiet side, and owing to the holidays and the consequent stoppage of the steel departments, there has been a fair amount of iron going into stock. The market is dull, and there appears to be a tendency on the part of customers to mark time until labour troubles and threats to the iron industry are removed. It is difficult to say exactly how much the coal trouble is affecting the trade, but it is obvious that the uncertainty is causing many people to refrain from placing orders for pig iron or to take only such quantities as will just keep them going. Orders for forward delivery are scarce at present, and there are no heavy deliveries. The trade with the Midlands is the best, but there is room for improvement even in it. The Scottish trade is rather thin at present, and the same remark applies to other districts in the country. The overseas trade is not of any importance as far as the Continent is concerned. There is a certain amount of business occasionally with America in semi-special qualities.

Iron Ore.

The iron ore trade remains the same with no great activity in any direction, and what practically amounts to stoppage in some respects. The mines are mostly relying on local demands, and there is not much going out of the district. Foreign ore is being bought in restricted tonnage until such time as the iron trade improves.

Steel.

The steel market is quiet and fresh orders are required by both Barrow and Workington to keep the mills employed. Both places have been closed for the holidays this week, but at Barrow the foundries are at work again and the hoop and small section mills are working.

SHEFFIELD.

(From our own Correspondent.)

A Shorter Holiday.

The present working week has only been half the usual length, as most of the Sheffield plants were shut down until Wednesday. There were some exceptions, notably at the works of Steel, Peech and Tozer, which ran practically throughout the holiday. The Stocksbridge Works, however, were closed for ten days. On the whole, the stoppage has been much shorter than that of last Easter, which suggests that the trade position is better. Of course, firms may find it necessary to extend the holiday owing to absence of orders, but this is not considered probable. That the steel trade is improving is shown by the fact that the country's output during February, amounting to 703,800 tons, was 63,400 tons more than that of January, and was the highest since May, 1924.

The Heavy Trades.

The railway steel section continues to be one of the busiest departments of the heavy trade, and is, in fact, better employed than it has been at any time during the past two years. The British railway companies, at the beginning of the year, placed large specifications for supplies of axles, tires, and springs under six and twelve months' contracts, but further contracts may be necessary in the course of the summer. There is still a lack of overseas business, and a moderate increase under this head would be sufficient to fill the plants up. There are grounds for thinking that the Indian and South American demand will increase in the near future. In other directions, too, there are cheering signs. One of these is the fact that shipbuilding is a little better. Another is that competition in cheap steel from France, Germany and Belgium is likely to be less than it has been in the past. An excellent demand is maintained for electrical machinery, and also for apparatus and material for the building trade.

The Lighter Side.

The production of steel and steel parts for motor cars continues on a large scale, and the departments concerned are well employed. The machine tool section is much better situated than it was two or three years ago, although its position is still far from satisfactory. An improvement is reported in the demand for internal combustion engines, and there is a request for textile machinery for Russia. The old staple light trades of Sheffield are still depressed. The departments for files, saws, edge tools and other hand tools, which have been looking up recently, have not recovered from the falling off which they experienced early this year. Although there are bright spots in cutlery and plate, the general condition of these trades remains stagnant, and there are no signs of general improvement. The production of stainless table knives is much below what has come to be regarded as the normal standard, and competition for the business is so keen that price cutting is on an increasing scale. It is now extending to Australia and other parts of the Empire, which in the past has given their business almost entirely to the high-class firms. A good seasonal trade is being done in garden tools.

Cutlery for America.

Although the cutlery trade as a whole is in an unsatisfactory condition, instances of considerable activity are to be found, and one of these is afforded by a firm which is at present doing an increased trade with the United States. Business with this quarter has, of course, been severely handicapped of late years by the heavy import duties, but the firm in question has now on hand some very substantial orders for that market, which are the first to be booked for some years. These orders are for table knives. The president of an important American firm told the Sheffield manufacturer that Sheffield cutlery beats both German and French products alike in price and quality, and that, at anything like competitive prices, it is easier to sell Sheffield-made cutlery than American home-manufactured goods. Other American buyers have informed the Sheffield house that if the tariff were reduced to 25 per cent. the American cutlery manufacturers would be put out of business. American clients who have factories in Canada are ordering Sheffield cutlery from the same firm to a very substantial degree. Experienced buyers report that on the European Continent Sheffield is holding its own in table knives, although it is at a heavy disadvantage in the matter of penknives and scissors.

Royal Saloon for Siam.

There has just been completed by Cravens Railway Carriage and Wagon Company, Ltd., of Darnall, Sheffield, a railway carriage of a special type, which is intended for use as a sleeping car for the King of Siam on the Royal State Railways of that country. The saloon is a remarkably handsome piece of work, and has attracted the favourable comments of many of the leading railway engineers in this country. Its total length over buffers is 60ft. 4in., length over body 57ft. 6in., width over body, 8ft., total height to top of roof from rail, 11ft. 7¾in. It is mounted on two four-wheel bogies of the swing bolster type, with side compensating beams constructed of pressed steel members. The wheels are of the rolled steel disc type. The framing of the car body is of teak, with exterior panels of sheet steel, and the body is insulated from underframe shocks by means of india-rubber cushions. The underframes are constructed of rolled steel sections, strongly braced together by means of gusset plates and knees. The saloon is arranged with a central entrance vestibule. On one side of this entrance the principal bed, dressing, and bathrooms occupy the full width of the car, while from the other side a corridor runs half the length of the car, communicating with the auxiliary bed, dressing, and bathrooms. A cylindrical water tank of 80 gallons capacity is attached to the frame, and from it water is raised by means of hand pumps in the bathrooms to the supply tanks above those compartments. The total water capacity is 205 gallons.

Other Railway Work.

The car is intended to work in traffic with a Royal saloon built in this country in 1915. The two will form a two-coach unit of identical external appearance, but the earlier one is arranged as a day saloon with a study, observation and dining rooms. Messrs. Cravens have previously supplied a number of vehicles to the Siamese railways, as well as to railway systems in various parts of the world. They are at present engaged on the completion of an order for fourteen carriages for the Cheshire Lines Committee, six of which were sent away last week-end to take part in the Easter traffic. The firm is also building a number of carriages for the Antofagasta, Chile, and Bolivia Railway; three huge restaurant cars, no less than 80ft. long and 12ft. wide, for the Central Argentina Railway, and other vehicles.

An Important New Company.

Last week-end the announcement was made of the registration of Darwins, Ltd., of Sheffield, as a public company, with a nominal capital of £500,000, consisting of 450,000 8 per cent. cumulative participating preference shares and 50,000 ordinary shares of £1 each. One of the main objects of the company is to take over the existing undertaking of Darwin and Milner, Ltd., to whose activities I have referred on several recent occasions. Darwin and Milner rather more than a year ago purchased the Sheffield Simplex Motor Works at Tinsley, and set about equipping them for the production, on a mass scale, of safety razor blades. The firm was already engaged in a variety of branches of the steel trade, but razor blades was a new departure, and it has now been developed to a very large and promising extent. The blades are made of a patented cobalt steel. The present output is about a million a week, and employment is found for about 1400 people, of whom nearly a thousand are girls, who all work in one great shop covering an acre of ground. It is intended to increase the output, and the number of employees very substantially, and the firm's future plans also include the application of cobalt steel to the whole range of cutlery.

Colliery Matters.

Changes have been made by the Staveley Coal and Iron Company in the system of turning coal at its Hartington Colliery, as a result of which the same tonnage can now be brought out in seven hours as formerly in fourteen hours. There are two shafts at the colliery, and turning is being transferred from one shaft to the other, namely, from the deep soft shaft, the cage of which has only one deck, to the deep hard shaft, which is worked with a double cage. It will thus be possible, in the future, to turn two shifts of coal in one shift, and this fact will make for economy in the cost of production. The screens are being extended to deal with the increased output. The Manners Colliery Company is to make application to the Railway and Canal Commission, on May 3rd, for permission to work the minerals under about twenty acres of land at Eastwood, about eight miles from Nottingham. The position is remarkable and unprecedented, because no one can be found to claim the royalties on the coal. The surface owner disclaims all right to them, and the colliery company has been unable to find anyone to treat with. When the case was mentioned in Court last week, Mr. Justice Sankey suggested that under the circumstances the minerals might belong to the Crown. He directed that the usual notices should be served, after which the application will come on for hearing.

NORTH OF ENGLAND.

(From our own Correspondent.)

Exports Best for Two Years.

A notable feature of the exports of pig iron, manufactured iron and steel from the Cleveland district for March is that they are the best recorded for two years past. The official total is returned at 113,213 tons, as compared with 97,640 tons in February, 92,630 tons in January, 89,401 tons in December, and 85,667 tons in November. These figures imply a steady and continuous improvement in the iron and steel industry, but, unfortunately, they cannot be wholly accepted at their face value. It is incontrovertible that there has been a successive expansion of exports month by month, but it is unfortunately equally true that the volume of new business during the past few weeks has been disappointingly small, and the heavy deliveries during March have been chiefly made under old contracts which, as they approach fulfilment, are not as yet being renewed. The relatively high price of Cleveland pig iron, as compared with that produced in the Midlands, and the still greater disparity between Cleveland and continental pig iron prices, the disturbed state of the continental exchanges due to the collapse of the French and Belgian francs, and the apprehensions regarding the coal trade, have all tended to restrict business. It is probable that the present pause among buyers of iron and steel is merely temporary, and it is significant that despite the contraction in the volume of business Cleveland pig iron makers have been so well situated that their stocks have been reduced to the lowest ebb. All their output is going into immediate consumption, and prices have shown no change for nearly three months.

Big Steel Exports.

The improvement in the exports was chiefly confined to the steel trade. About 2000 tons more pig iron was shipped than in February, the increase being accounted for by heavier deliveries to Italy, 4045 tons, and the United States, 6130 tons. Altogether, the foreign shipments of pig iron totalled 20,006 tons, compared with 14,680 tons in February, whilst the coastwise shipments reached only 15,949 tons, as against 19,316 tons in February. The total of 77,258 tons of manufactured iron and steel shipped during March was not equalled in any month since December, 1923. Over 18,000 tons went to India and Ceylon, whilst a shipment of 10,006 tons to the various South American Republics was without parallel in the history of the trade. Another encouraging feature was that 8534 tons were shipped to Egypt.

Cleveland Iron Market.

Market conditions in the Cleveland pig iron trade are practically unchanged. The Easter holidays have accentuated the slackness of the demand and deliveries have been curtailed to a considerable extent, owing to the fact that many of the consuming works have closed down for a full week. Foreign business, too, is almost unobtainable at present prices, whilst the steady fall of the franc is another unsettling factor. But makers show no sign of yielding, and adhere firmly to recent quotations:—No. 1 Cleveland foundry iron, 72s. 6d.; No. 3 G.M.B., 70s.; No. 4 foundry, 69s.; No. 4 forge, 68s. 6d.; and mottled and white iron, 68s. In the case of export orders 6d. per ton extra is charged.

Hematite Pig Iron.

The East Coast hematite pig iron trade shows no improvement. Makers have made a further cut of 6d. per ton in prices without stimulating business to any appreciable extent. Mixed numbers are now quoted at 76s. 6d. and No. 1 at 77s. per ton, both for home use and for export.

Ironmaking Materials.

Business in the foreign ore trade is practically at a standstill. Consumers have heavy stocks, and large cargoes continue to arrive under running contracts. Best Rubio ore is nominally 21s. 3d. per ton c.i.f. Tees. Good medium blast-furnace coke is still quoted at 19s. per ton on a weak market.

Manufactured Iron and Steel.

With one or two exceptions, the steel works on the North-East Coast are closed down for the week. Business continues on a quiet scale, but a little more activity is reported for shipbuilding materials. Prices are unchanged.

Iron and Steel Imports.

Statistics presented at a meeting of the Tees Conservancy Commission on Wednesday showed that the imports of pig iron and steel from European countries and India during the past five months totalled 94,999 tons, as compared with 75,206 tons in 1924–25, and 31,266 tons in 1913–14. The imports of pig iron reached 30,000 tons, an increase of 23,613 tons as compared with the corresponding period of 1924–25. In the same period of 1913–14 only 54 tons of pig iron were imported. Crude sheet bars, billets, blooms, slabs, &c., brought to the port totalled 58,855 tons, as compared with 58,596 tons in 1924–25, and 19,970 tons in 1913–14. There was, however, a marked reduction in the imports of plates, bars, angles, rails, sheets, joists, &c., which totalled 6144 tons, against 10,113 tons a year ago, and 11,242 tons in 1913–14.

The Coal Trade.

The tone of the Northern coal trade is very firm, owing to uncertainty regarding the negotiations between owners and miners, and holders of coal are asking higher prices for this month's delivery. Buyers are not eager to commit themselves at enhanced prices, and prefer to await further news. From the Continent consumers are showing very little interest in the possible developments, apparently being satisfied that they can secure ample supplies of coal from other countries, if any stoppage takes place on this side. Prices, while firmly quoted, are merely

nominal, through lack of transactions. The new ascertainments governing wages in Northumberland and Durham are interesting. If the miners had to rely upon an economic yield their wages would be very low, for in Northumberland the rate would be 35.42 per cent., and in Durham 35.76 per cent. As compared with March there is a slight decrease in Durham, for the figures then were 36.24 per cent., and Northumberland is higher, for the March returns were 33.03 per cent. The Northumberland miners will have to receive 64.58 per cent. from the Government in order to make up their earnings, and the Durham miners will have to rely upon the subsidy to the extent of 74.24 per cent.

SCOTLAND.

(From our own Correspondent.)

Clyde Shipbuilding.

COMPARED with the same period last year, the output from Clyde yards during last month shows a decrease of more than 50 per cent. The number of vessels nearing completion has been greatly reduced, and though fresh contracts have been more numerous of late, some time must elapse ere the rate of production can be speeded up. During last month fourteen vessels, of 33,391 tons aggregate, were launched from Clyde yards, compared with thirty-two vessels, of 73,956 tons, in March 1925. Similarly the returns for this year to date, amounting to thirty-nine vessels, of 84,390 tons aggregate, show a considerable decrease when compared with the returns for the first three months of last year, which amounted to fifty-two vessels, of 143,458 tons. Chief amongst the vessels launched last month was the armoured cruiser Berwick, 10,000 tons, built at the Fairfield Shipbuilding and Engineering Company's yard at Govan. Included in the list were the Sabbia cargo steamer, 5915 tons, built for the Navigazione Liberia Triestina, Trieste; Nerissa, passenger and cargo, 5500 tons, for the New York, Newfoundland and Halifax Steamship Company (the Red Cross Line), Liverpool; and the Bayrupert, passenger and cargo, 4000 tons, for the Hudson's Bay Company, London. Fresh contracts were not so numerous as in January and February, but several orders of importance were reported, including a Houlder Line motor ship of about 9100 tons, and a 20,000-ton motor liner for the Shaw, Savill and Albion Company, for its New Zealand service, *viâ* the Panama Canal.

Iron.

The general situation at the ironworks is without change. Business is scarce, and prices are very keen, despite the fact that quotations are nominally unchanged. Anyone with a good order to place can gain exceptionally keen terms at present. Re-rolled steel likewise is in quiet demand, and prices a matter of arrangement. Pig iron holds nothing of fresh interest, the turnover being still confined to small lots, with quotations barely steady at recent levels.

Steel Prices.

The feature during the past week was the announcement that the Steelmakers' Association had decided to control ship plates and sections for home consumption and of plates for export. As the latter have been free for a considerable period, their inclusion now has caused surprise. It is hoped that this movement will give a feeling of stability to the market, and inspire greater confidence. Prices were fixed as follows:—Plates, £7 10s.; sections, £7 per ton for home consumption, and £7 per ton for plates for export.

Steel Sheets.

There is little that calls for fresh comment in connection with steel sheets. Some producers of black and galvanised descriptions are so well booked up on home and export demand that they cannot meet all requests in the meantime. Heavy gauges are quieter, however, owing to the competition from light plates.

Coal.

With one or two exceptions, all descriptions of fuel are greatly in need of fresh business, especially in the export department. Severe competition from abroad, and the possibility of labour trouble in the industry, have caused a stiffening of certain fuels, which must not be attributed to an increase in business. Lanarkshire splints are an exception to the rule, however, as that fuel is heavily booked, and cannot now be obtained unless through second-hands. The collieries in Fifeshire and the Lothians are hard hit by the lack of export orders, and stocks of practically all classes of fuel are accumulating. Supplies of coal for home consumption are plentiful.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Outlook.

THE coal trade outlook remains as obscure as ever. This is, in the main, the general view, notwithstanding the publication of the proposals put forward by the coalowners. These proposals are interesting inasmuch as they show that the coalowners are prepared to go further than was expected towards bringing about a settlement, though it must be admitted that the proposals are only a preliminary to the real negotiations, which will centre around the question of hours of work and wages and a return to district agreements. As regards a number of the Coal Commission's recommendations, the coalowners have signified their approval of them in principle, but there are several about which the coalowners are non-committal. On the whole, it is questionable whether the coalowners' proposals contribute very materially towards an advance to agreement, though at the same time they serve to show to some extent where the coalowners stand. On the other hand, the answer of the miners to them is a complete negative. They make no contribution of any sort which narrows down the issue. Since neither side has accepted the report of the Commission, the question is raised as to what will be the position of the Government, inasmuch as the Prime Minister stated at the outset that the Government was prepared to accept the report, provided that it was accepted without qualification by the coalowners and the miners. The three representatives of the South Wales Miners' Federation on the National Executive gave their report on the national situation to the members of the South Wales Council on Saturday, and arrangements were made for their attendance at the national conference to be held this week, but no statement was issued as to the line of action they are to take. A further meeting of the South Wales Executive Council was to be held on Wednesday. There was also a meeting of the Executive Committee of the South Wales Miners' Minority Movement at Cardiff on Saturday, when a resolution was passed that the conference should work vigorously and perseveringly for the full rejection of the Coal Commission's report, and it was agreed to recommend to all sections of the South Wales Miners' Federation the rejection of the report.

Notices Suspended.

A fortnight ago notices were given to 800 men employed at the Great Western Collieries, Pontypridd, to expire on Saturday last, and allowing for some of the workmen finding work at other pits, it was fully expected that about 500 would be added to the list of unemployed in the district. The official announcement was made, however, on Saturday that the dismissals would not take place, and that the whole of the workmen affected by the notices would continue to work on day-to-day contracts.

Steel and Tin-plate Works to Close.

There was bad news during the recent holidays for a number of steel and tin-plate workers. At Llanelly notices were posted up last Friday at the South Wales Steel Works of Richard Thomas and Co. that the management intended to close down temporarily a section of the works, affecting about 500 men. This means that four furnaces out of ten at the works will become idle. The effect upon the workmen directly engaged at the furnaces will be serious, as it means that nine sets of workmen will be allocated to the reduced number of furnaces working, and the working arrangements will only permit of the men working at most two days per week. The same firm also tendered on Saturday twenty-eight days' notices to its workmen at the Burry Tin-plate Works, where about 500 men are employed. The company intends to carry out a scheme of alterations and improvements to its plant. The Gorse Galvanising Works, Llanelly, have been temporarily closed down for repairs and extensions, while the workmen employed at the Pontypool Tin-plate Works received notices during last week-end terminating their engagements at the end of this month. It is understood that this step has been taken because of a lack of orders.

Safety Men and Mines.

The Executive Committees of the South Wales Colliery Examiners' Association, the South Wales Enginemen, Boilermen and Craftsmen's Association, and the South Wales Colliery Officials' Union met at Cardiff on Tuesday, the purpose being to consider the policy to be pursued by the safety men who belong to all three unions. The Executives met separately and representatives of each afterwards met jointly for discussions. They resolved to do their utmost to maintain the safety of the mines in case of trouble at the end of the month. No definite plans of a joint character were agreed upon.

Current Business.

There has been no business in coals since the early part of last week, and there is no prospect of the market resuming before the end of this week or early next week. The holidays have quite ruled out operations, inasmuch as there was no work in the coalfield until Thursday, and no work at the docks until Wednesday. Most buyers had made their arrangements for the loading of boats due immediately after the vacation some time ago, and, furthermore, stems had become so tight that it was very difficult to obtain any of the leading qualities for shipment during the first half of this month. There is little doubt that loading pressure will continue very active throughout the whole of April, and the tendency of prices is upward, particularly in the case of the better grades of small coals. For the moment, the market is really only nominal, and it will be next week before many undertakings will be able to gauge their position accurately, and know whether they will have any coals for disposal for anything like early shipment. There was, of course, a substantial exodus of loaded tonnage just before the holidays, so that a number of idle loading appliances were reported at the various docks, but fresh arrivals were expected to be sufficiently numerous to provide the collieries with a ready outlet for their coals when work was resumed after the vacation.

LAUNCHES AND TRIAL TRIPS.

ATHELKING, motor ship; built by Swan, Hunter and Wigham Richardson, Ltd.; to the order of the British Molasses Company, Ltd.; dimensions, 475ft.; to carry molasses and oil or spirit in bulk. Engines, twin-screw oil reversible single-acting marine type; constructed by the builders; trial trip, March 4th.

OAKBANK, motor vessel; built by Harland and Wolff, Ltd.; to the order of The Bank Line, Ltd.; dimensions, 434ft. by 53ft. 9in. by 37ft. Engines, Harland-B. and W. motors; constructed by the builders; delivered, March 11th.

BELPAREIL, motor ship; built by Sir W. G. Armstrong, Whitworth and Co., Ltd.; to the order of Rederiet Belpareil, Oslo; dimensions, 427ft. 6in. by 68ft. by 33ft. 6in.; 10,375 tons deadweight. Engines, twin-screw Armstrong Sulzer two-cycle Diesel; 600 mm. diameter by 1060 mm. stroke; constructed by the builders; launch, March 15th.

JOHN S. PILLSBURY, steamer; built by Earle's Shipbuilding and Engineering Company, Ltd.; to the order of The Eastern Steamship Company, Ltd., of Canada; dimensions, 258ft. by 44ft. by 20ft.; 2510 tons deadweight. Engines, triple-expansion, surfacing-condensing; 17in., 28in., 46in. diameter by 33in. stroke; pressure, 180 lb.; constructed by the builders; trial trip, March 15th.

STUARTSTAR, steel screw steamer; built by Palmer's Shipbuilding and Iron Co., Ltd.; to the order of The Blue Star Line (1920), Ltd.; dimensions, 494ft. long, 11,750 tons deadweight. Engines, twin-screw single-reduction geared turbines; constructed by the builders; launch, March 15th.

DOMINIA, cable steamer; built by Swan, Hunter and Wigham Richardson, Ltd.; to the order of the Telegraph Construction and Maintenance Company, Ltd.; dimensions, 510ft. by 59ft. by 40ft. 9in.; 9250 gross tonnage. Engines, twin-screw triple expansion; constructed by the builders; launch or trial trip, March 16th.

SHIRAK, oil tanker; built by Sir W. G. Armstrong, Whitworth and Co., Ltd., to the order of the Baltic Trading Company. Engines, direct-acting, surface condensing, pressure 180 lb.; constructed by the builders; trial trip, March 16th.

ACCRA, motor passenger liner; built by Harland and Wolff, Ltd., to the order of Elder, Dempster and Co., Ltd.; dimensions, 468ft. 9in. by 62ft. by 35ft.; 9200 gross tonnage. Engines, Harland-B. and W. six-cylinder, four-cycle, double-acting, Diesel; constructed by the builders; launch, March 18th.

PECTEN, oil tank vessel; built by Palmer's Shipbuilding and Iron Company, Ltd., to the order of the Anglo-Saxon Petroleum Company, Ltd.; dimensions, 440ft.; 9900 tons deadweight. Engines, single-screw, four-cycle, six-cylinder, double-acting Werkspoor; constructed by the North-Eastern Marine Engineering Company, Ltd.; launch, March 30th.

CATALOGUES.

SKODA WORKS, Ltd., Prague, Czechoslovakia.—Catalogue of steam turbines.

ALFRED HERBERT, Ltd., Coventry.—Brochure entitled "Cutting Costs with Coventry Dieheads."

BRITISH INSULATED CABLES, Ltd., Prescot, Lancs.—Catalogue P. 195 dealing with paper insulated cables.

R. JENKINS and Co., Ltd., Rotherham.—Booklet describing many types of wrought steel welded boilers.

PENNEY AND PORTER (ENGINEERS), Ltd., Lincoln.—Leaflets on the uses of the "Littlejack" pulling jack.

W. CHRISTIE AND GREY, Ltd., 4, Lloyd's-avenue, E.C. 3.—Booklet on the isolation of vibration and noise.

THE BUTLER MACHINE TOOL COMPANY, Ltd., Halifax.—Sheet No. 7A, dealing with "Butler" general purpose lathes.

JAMES KEITH AND BLACKMAN COMPANY, Ltd., 27, Farringdon-avenue, E.C. 4.—Brochure on paddle-wheel fans, type P.

ROYLES, Ltd., Irlam, near Manchester.—Brochure illustrating and describing the new "Millether" feed-water heater.

HERBERT MORRIS, Ltd., Loughborough.—Book 181, describing the "Morris" retort charger and other gasworks equipment.

THE BIRMINGHAM SMALL ARMS COMPANY, Ltd., Birmingham.—Leaflet describing the "B.S.A." universal lapping machine.

HIGGS MOTORS, Ltd., Witton, Birmingham.—Latest price list for all types of electric motors from ¼ to 50 horse-power.

OERLIKON, Ltd., 28-31, Essex-street, W.C. 2.—Oerlikon Bulletins Nos. 52, 53 and 54, dealing with the activities of the company.

CONTRACTS.

THE NEW CONVEYOR COMPANY, Ltd., of Smethwick, has received from the Corporation of the City of Birmingham an order for the installation of band conveyors and screening plant at the Nechells gas works.

THE five new multi-engined Handley Page air liners that were delivered to Imperial Airways, Ltd., at Croydon, on March 30th will be equipped with standard type Marconi A.D. 6 wireless installations for telephonic and telegraphic communication.

INTERNATIONAL COMBUSTION, Ltd., of Africa House, Kingsway, London, W.C. 2, has received orders for steam generating Lopulco combustion equipment from the North Metropolitan Electric Supply Company, the South African Electricity Commission, the Compagnie Espagno-Americano (Buenos Aires), and Shell-Mex. Ltd. It has also received an order for pulverised fuel equipment for an existing boiler plant from the Anglo-Persian Oil Company, Ltd.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

ARCHIBALD D. DAWNAY AND SONS, Ltd., Battersea, S.W. 11, notify us that their telephone number is now Battersea 2525 (six lines).

G. BAILEY TOMS AND CO. (William B. Gunn), of 8, Laurence Pountney-hill, London, E.C. 4, ask us to announce that in accordance with the requirements of the telephone service their numbers have been changed from Bank 6141 and Bank 550 to Royal 7762 and Royal 7763.

MR. ALAN A. CAMPBELL SWINTON, F.R.S., M. Inst. C.E., M.I.E.E., M.I. Mech. E., is retiring from the electrical and general consulting engineering practice that he has carried on for the past thirty-seven years at 66, Victoria-street, Westminster, S.W. 1. He will, however, continue special consulting work at 40, Chester-square, London, S.W. 1, which henceforth will be his sole permanent address.

LANTERN SLIDES.—Petters Ltd., of Yeovil, announce that they have prepared a series of lantern slides, illustrating their oil engines, and that they will be pleased to place them at the disposal of those who may contemplate giving lectures and papers on internal combustion engines.

THE ROYAL GOLD MEDAL FOR ARCHITECTURE.—At a special general meeting of the Royal Institute of British Architects, held on March 29th, Professor Ragnar Ostberg—honorary corresponding member of the R.I.B.A.—of Stockholm, was elected by the members, and his name will be submitted to his Majesty the King as a fit recipient of the Royal Gold Medal for Architecture for the year 1926. In the event of his Majesty signifying his approval of the award, the medal will be presented to Professor Ragnar Ostberg at the banquet of the R.I.B.A. on June 17th. The medal was presented last year to Sir Giles Gilbert Scott, R.A., F.R.I.B.A.

Current Prices for Metals and Fuels.

IRON ORE.

N W. Coast—	
Native	21/-
1) Spanish	18/6
(1)N. African	18/6
N.E. Coast—	
Native	—
Foreign (c.i.f.)	21/3

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	3 17 0	—
No. 1 Foundry	3 19 0 to 4 1 6	
No. 3 Foundry	3 16 6 to 3 19 0	
N.E. Coast—		
Hematite Mixed Nos.	3 16 6	3 16 6
No. 1	3 17 0	3 17 0
Cleveland—		
No. 1	3 12 6	3 13 0
Silicious Iron	3 12 6	3 13 0
No. 3 G.M.B.	3 10 0	3 10 6
No. 4 Foundry	3 9 0	3 9 6
No. 4 Forge	3 8 6	3 9 0
Mottled	3 8 0	3 8 6
White	3 8 0	3 8 6
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
„ „ Foundry	4 7 6	—
(3) Northampton—		
Foundry No. 3	3 3 0 to 3 4 6	
„ Forge	2 16 0 to 2 17 0	
(3) Derbyshire—		
No. 3 Foundry	3 6 0 to 3 7 0	
Forge	3 0 0 to 3 2 0	
(3) Lincolnshire—		
No. 3 Foundry	3 8 0	—
No. 4 Forge	3 5 6	—
Basic	3 6 0	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 10 0 (a) / 4 12 6 (b) / 4 17 6 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	11 5 0	—
Best	—	—
N.E. Coast—		
Common Bars	11 0 0	—
Lancs.—		
Crown Bars	11 10 0	—
Second Quality Bars	10 5 0	—
Hoops	14 0 0	—
S. Yorks.—		
Crown Bars	12 10 0	—
Best „	13 10 0	—
Hoops	14 10 0	—
Midlands—		
Crown Bars	11 0 0 to 12 0 0	
Marked Bars (Staffs.)	14 0 0	—
Nut and Bolt Bars	10 5 0 to 11 0 0	
Gas Tube Strip	12 10 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	11 0 0	—
Ship Plates, ½in. and up.	7 10 0	7 0 0
Sections	7 0 0	—
Steel Sheets, under 3/16in. to ½in.	9 0 0	—
Sheets (Gal. Cor. 24 B.G.)	—	£16 to £16 5 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	7 10 0	—
Angles	7 0 0	—
Boiler Plates	11 10 0	—
Joists	7 0 0	—
Heavy Rails	8 0 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 2 6	—
Soft Billets	7 5 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 0 0†	—
Light „	8 5 0 to 8 10 0	
Billets	7 10 0 to 9 0 0†	
Manchester—		
Bars (Round)	8 0 0 to 8 5 0	
„ (others)	8 0 0 to 8 5 0	
Hoops (Best)	13 5 0	13 0 0
„ (Soft Steel)	10 0 0	9 15 0
Plates	7 15 0	—
„ (Lancs. Boiler)	11 10 0	—
Sheffield—		
Siemens Acid Billets	10 10 0	—
Bessemer Billets	11 5 0	—
Hard Basic	8 12 6	—
Intermediate Basic	8 2 6	—
Soft Basic	8 15 0	—
Hoops	12 0 0	—
Soft Wire Rods	9 10 0	—
Midlands—		
Small Rolled Bars	7 15 0 to 8 0 0	
Billets and Sheet Bars	6 0 0 to 6 2 6	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	15 17 6 to 16 5 0	
Angles	7 0 0	—
Joists	7 0 0	—
Tees	8 0 0	—
Bridge and Tank Plates	7 15 0	—
Boiler Plates	11 0 0 to 11 10 0	

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	19/3 to 19/6
Block Tin (cash)	282 10 0
„ (three months)	275 7 6
Copper (cash)	57 2 6
„ (three months)	58 0 0
Spanish Lead (cash)	31 12 6
„ (three months)	31 16 3
Spelter (cash)	33 17 6
„ (three months)	34 2 6
Manchester—	
Copper, Best Selected Ingots	62 7 6
„ Electrolytic	65 10 0
„ Strong Sheets	90 0 0
„ Tubes (Basis Price)	0 1 1
Brass Tubes (Basis Price)	0 1 0
„ Condenser	0 1 2½
Lead, English	31 12 6
„ Foreign	30 15 0
Spelter	33 17 6

FERRO ALLOYS.

(*All prices now nominal.*)

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/1 per lb.	
Ferro Tungsten	1/9½ per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£22 10 0	7/6
„ 6 p.c. to 8 p.c. „	£22 0 0	7/3
„ 8 p.c. to 10 p.c. „	£20 15 0	6/6
„ Specially Refined		
„ Max. 2 p.c. carbon	£38 10 0	12/6
„ „ 1 p.c. „	£44 10 0	15/-
„ „ 0·70 p.c. carbon	£54 10 0	17/6
„ „ carbon free	1/5½ per lb.	
Metallic Chromium	3/3 per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
„ Silicon, 45 p.c. to 50 p.c.	£11 15 0 scale 5/- per unit	
„ „ 75 p.c.	£20 10 0 scale 6/- per unit	
„ Vanadium	14/6 per lb.	
„ Molybdenum	6/- per lb.	
„ Titanium (carbon free)	0/11½ per lb.	
Nickel (per ton)	£170	
Cobalt	10/- per lb.	
Aluminium (per ton)	£112	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	14/6
„ „ Ell	15/6
„ „ Splint	16/6 to 19/9
„ „ Trebles	15/-
„ „ Doubles	13/3
„ „ Singles	12/9 to 13/-
Ayrshire—	
(f.o.b. Ports)—Steam	15/3
„ „ Jewel	16/6
„ „ Trebles	15/6
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	12/3 to 15/-
Screened Navigation	21/-
Trebles	13/6 to 14/6
Doubles	13/6
Singles	12/- to 12/6
Lothians—	
(f.o.b. Leith)—Best Steam	14/-
Secondary Steam	13/3
Trebles	14/- to 14/6
Doubles	13/3
Singles	12/-

ENGLAND.

(3) N.W. Coast—	
Steams	24/-
Household	40/- to 48/-
Coke	26/-
Northumberland—	
Best Steams	16/3 to 17/-
Second Steams	14/- to 14/6
Steam Smalls	8/- to 9/6
Unscreened	13/- to 13/6
Household	20/- to 22/-
Durham—	
Best Gas	17/6 to 18/-
Second	14/6 to 15/-
Household	20/- to 22/-
Foundry Coke	18/- to 20/-
Sheffield—	Inland.
Best Hand-picked Branch	31/- to 34/-
Barnsley Best Silkstone	28/- to 30/- —
Derbyshire Best Brights	26/- to 28/- —
„ „ House	24/- to 25/- —
„ „ Large Nuts	17/- to 20/- —
„ „ Small	12/6 to 14/- —
Yorkshire Hards	17/- to 19/6 —
Derbyshire „	16/- to 19/- —
Rough Slacks	10/- to 12/6 —
Nutty „	7/6 to 9/- —
Smalls	3/6 to 6/- —
Blast-furnace Coke (Inland)*	— —
„ „ (Export) f.o b.	16/- to 17/-

(9) SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Smokeless Large	24/- to 24/6
Second „ „	22/6 to 23/6
Best Dry Large	22/- to 24/-
Ordinary Dry Large	19/6 to 20/6
Best Black Vein Large	22/3 to 22/6
Western Valley Large	21/- to 22/-
Best Eastern Valley Large	21/- to 22/-
Ordinary „ „	19/6 to 20/6
Best Steam Smalls	14/- to 15/-
Ordinary „	12/- to 13/6
Washed Nuts	19/- to 26/-
No. 3 Rhondda Large	26/6 to 27/-
„ „ Smalls	16/- to 16/6
No. 2 „ Large	19/6 to 20/6
„ „ Through	16/6 to 18/6
„ „ Smalls	10/6 to 11/6
Foundry Coke (export)	40/- to 50/-
Furnace Coke (export)	25/- to 30/-
Patent Fuel	21/- to 22/6
Pitwood (ex ship)	24/- to 24/6
Swansea—	
Anthracite Coals:	
Best Big Vein Large	39/- to 40/-
Seconds	30/- to 32/6
Rod Vein	27/- to 29/-
Machine-made Cobbles	50/- to 52/6
Nuts	50/- to 52/6
Beans	40/- to 42/6
Peas	21/- to 24/-
Breaker Duff	6/- to 7/-
Rubbly Culm	11/- to 11/3
Steam Coals:	
Large	22/- to 23/-
Seconds	20/- to 22/-
Smalls	9/- to 10/-
Cargo Through	16/- to 17/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast-furnaces only, 17/-, with fluctuations according to analysis; open market, 17/6 to 19/- at ovens. † Latest quotations available. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

The Rail Union.

THE constitution of the international rail union is still awaiting a final adjustment of details. It is expected that everything will be completed at an early date. Of the countries belonging to the union it is understood that the participation of the Anglo-American group will be 43 per cent., the Franco-German 40 per cent., and the Belgian-Luxemburg group 17 per cent. As the United States legislation does not permit American railmakers to belong officially to any trust, the British firms will share their participation with the Americans, presumably to the extent of approximately one half, while the French and Germans will make over a part of their shares to Poland and Czecho-Slovakia respectively. It is reported that the Czecho-Slovakian participation will not be more than 5 per cent., so that if the same amount be accorded to Poland, France and Germany will each have 15 per cent. Should Great Britain give 20 per cent. to the United States its participation will be much below its share in the union before the war, when it had 30 per cent., but continental firms point out that their production of rails has increased so considerably since then that British makers are really favoured in obtaining the percentage accorded to them. It is stated that the headquarters of the union will be in London.

The Colliery Industry.

In the annual report of the Comité des Houillères de France the situation of the coal industry is presented in a distinctly favourable light. As the consumption exceeds the home production coalowners are sure of their own market and know that, however much they increase the output, they can always dispose of their fuel so long as they have the assistance of the State in checking the competition of imported coal. During the past six years the proportion of coal supplied by French collieries as compared with the consumption has increased steadily from 42 per cent. to 64 per cent. The output in 1925 was 48,054,000 tons, and the production in January this year, if continued, would bring the annual total to 51,000,000 tons, or 25 per cent. more than the pre-war output. The reconstruction of coke ovens in the Nord and the Pas de Calais resulted in the production of industrial coke being increased to 3,065,000 tons in 1925, and that total is now being largely augmented by the new ovens which have recently been put into operation and by the construction of several others. A serious disability of the French collieries is the situation of two-thirds of their number in the extreme north, which places a heavy burden upon them in the way of freight, and this, it is said, is equivalent to the putting of an import duty on foreign products. The organisation of the industry, in conjunction with the railway companies, is therefore regarded as necessary for its future prosperity. Another difficulty under which the coal trade labours is the heavy demand made upon it by the State. While the net dividends paid to shareholders have increased from 2·11f. in 1913 to 4·58f. in 1925, representing a rise of 217 per cent., wages have risen by 535 per cent., and the participation of the State in the profits distributed has increased more than tenfold. It is therefore clear that the miners and the State get their fair share out of the coal industry, while the shareholders, in view of the depreciated currency, are considerably worse off than they were before the war.

Electricity Tariffs.

An unsettling factor in the problem of insuring a universal distribution of electrical energy is the difficulty of knowing what the user will be called upon to pay. He is informed that by employing a source of energy that is not wasteful he is saving money himself and is enabling the country to economise by diminishing the importation of coal. The propaganda has proved remarkably successful, for the past year or two has seen a more rapid development of electrical distribution than ever before. The price is lower than in most other countries, and, because of that fact, power users have certainly been encouraged to employ electricity, although it is found that if the price is low the accessory charges are high. The Syndicat des Industries Mécaniques de France states that in the Paris district there are 3500 engineering shops equipped electrically. Some months ago the tariff was increased by 20 per cent., and the municipal council has now authorised a further rise of 15 per cent., which is arousing very strong protests from the Syndicat des Industries Mécaniques. This rise is, of course, an inevitable result of the increased cost of coal, but it is urged that such increased cost does not justify the total rise of 50 per cent. in the cost of electricity which has taken place within a year. The syndicate affirms that many of its members have gone back to other forms of energy supply, and it points to the possibility of the present extension of electrical distribution being arrested unless consumers can have some guarantee that they will not be made the victims of sudden increases in price. Other associations have been making vigorous protests to the Minister of Public Works against municipalities being authorised to tamper with electricity tariffs, and feeling is so strong upon this matter, that, it is understood, the proposal to increase the rates may be withdrawn.

Tunnel Ventilation.

The Mornay Tunnel, 2500 m. long, through which passes the single track railway between Bourg and Bellegarde in the department of Ain, has always been a source of danger to travellers on account of the accumulation of foul air at the apex of the two opposing gradients. Some time ago a goods train was unable to advance further when nearing the highest point of the tunnel. The guard succumbed to the effects of the foul air, and help had to be obtained to save the driver and fireman. It was then decided to install an efficient system of ventilation, and the work was entrusted to the Société Rateau, which erected at the higher level entrance an apparatus of the same type as that employed for the ventilation of mines. The cone fits into the upper part of the tunnel, and it is found that with one ventilator any risk of an accumulation of foul air is entirely obviated. A second ventilator is installed as a stand by.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

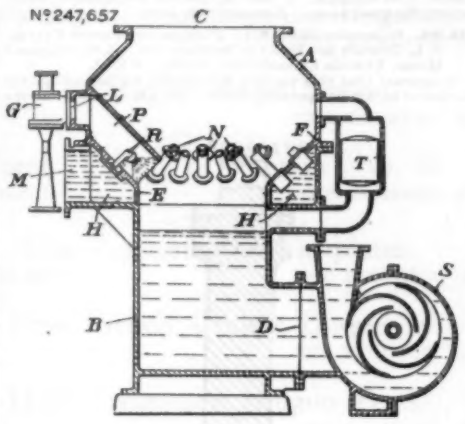
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

CONDENSERS AND FEED-WATER HEATERS.

247,657. November 19th, 1924.—IMPROVEMENTS IN STEAM CONDENSING PLANT, Harry Fothergill, of 3, Central-buildings, Westminster, S.W. 1, and Harold Gwynne Allen, of The Dene, Woburn Sands, Bedford.

The condenser shell consists of two portions, an upper portion A having an exhaust steam inlet C, and a lower portion B having a water outlet D connected to the extraction pump. The upper portion A is extended at E until it meets the smaller diameter of the lower portion B. The two parts are connected together by a flanged joint F, the annular space

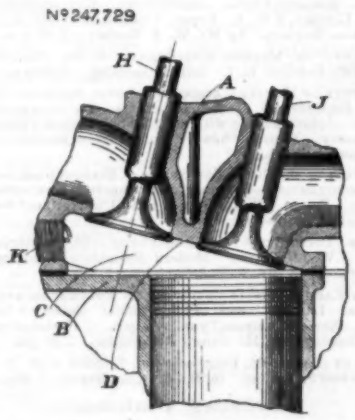


H forming the water inlet chamber. The inner wall E of the water chamber H is provided with nozzles N, through which the water supplied through the branch M is sprayed or otherwise introduced into the steam space above. Any suitable type of air pump, such as a steam operated ejector G, is connected to the air outlet L for removing the air and uncondensed vapour from the condenser and a downwardly extending passage P provided with a vapour condensing nozzle R may be provided. A vacuum breaking device may be operated in a known manner by a float T placed in a separate chamber.—*February 19th*, 1926.

INTERNAL COMBUSTION ENGINES.

247,729. February 3rd, 1925.—IMPROVEMENTS IN CYLINDER HEADS FOR INTERNAL COMBUSTION ENGINES, Renwick and Bertelli, Ltd., of King's-road, Tyseley, Birmingham, and William Somerville Renwick, of Clinton House, Kenilworth, Warwickshire.

A detachable head A is provided for the cylinder block, a part of which is shown at B. Combustion chambers, such as C, are formed in the head, the contours of which in an axial plane of the cylinder transverse to the crank shaft being of wedge form. The width and length of the wedge are sufficient without resorting to extreme and unsuitable proportions to provide for valves H and J of greater diameters than could be obtained in an

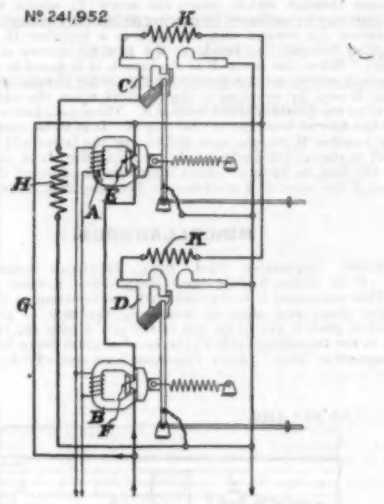


ordinary overhead valve engine. The shallowest part of the combustion chamber commences at one side of the cylinder bore, and the deeper part extends beyond the opposite side of the bore over the face of the cylinder block. The inlet and exhaust valves are arranged side by side in the end face D of the combustion chamber, and their spindles H and J are parallel. Machining is thereby simplified, as is also the arrangement of the valve-operating mechanism. The sparking plug K is at the side of the head A. The arrangement is claimed to be highly favourable for the production of turbulence of the working fluid at the moment of ignition, and it allows valves of unusually large size to be employed without adversely affecting the turbulence.—*February 25th*, 1926.

SWITCHGEAR.

241,952. October 20th, 1925.—METHOD OF OPERATING HIGH-SPEED SWITCHES FOR HEAVY CURRENTS, *International General Electric Company, Incorporated, of* 120, *Broadway, New York, United States of America.*

High-speed switches for heavy currents—for example, for 3000–10,000 ampères—have such a great mass in their movable parts—contact brushes, breaking members, magnet armatures, &c.—that it is very difficult to obtain the necessary speed of operation. According to this invention, this drawback is overcome by using several high-speed switches connected in parallel, and in order to ensure that the different switches release at the same time, the main current windings of the holding magnets are connected in series. In the drawing A and B are the two



holding magnets for the main contacts C and D, which are connected in parallel. The main current windings E and F for the two holding magnets A and B are connected in series, and through them the total current either flows direct or is branched off by a shunt which is represented in the drawing as a single wire G of appropriate cross-section. H is a damping resistance in parallel with the switch contacts. The two blow-out coils for the switches are shown at K.—*February 25th*, 1926.

TRANSFORMERS AND CONVERTERS.

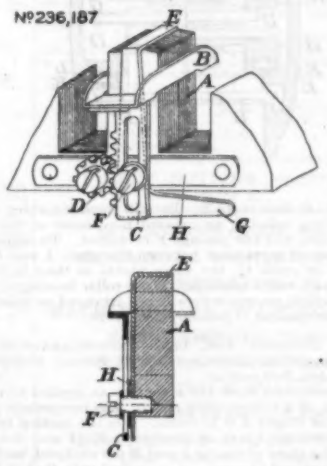
247,824. July 4th, 1925.—DISTRIBUTING TRANSFORMER, *Western Electric Company, Ltd., of Connaught House, Aldwych, London, W.C. 2.*

The object of this invention is to increase the all-day efficiency of distributing transformers, not only by increasing the operating efficiency, but also by decreasing the core losses which take place whether or not the transformer is delivering power. The core material employed, consists of iron and nickel, which, when subjected to the proper heat treatment, develops and retains an extremely high permeability when operated at flux densities of the order used in distributing transformers, and it has a very low hysteresis factor. To obtain the core material for this type of transformer, iron and nickel are fused together in an induction furnace, preferably in the proportion of about 21¼ per cent. iron and 78¾ per cent. nickel, good commercial grades of these metals being suitable for the purpose. The molten composition is poured into a mould and cooled, either in the form in which it is ultimately to be used or in a convenient form to be worked for that purpose. In the latter case it may be drawn or rolled. While 78¾ per cent. nickel and 21¼ per cent. iron are mentioned as being the proportion of the ingredients of nickel and iron to be employed in making up this crude material, the proportion may deviate considerably from these figures when nickel and iron are the only ingredients, and when other ingredients are included this proportion may not apply. Other ingredients than nickel and iron may be employed for various purposes, as, for example, it may be desirable to add chromium for the reason that a comparatively small quantity of this element will cause a decided increase in the resistivity of the composition, and this resistivity is a desirable factor in cutting down the eddy current loss. To obtain the utmost permeability in the magnetic material, the cores may be subjected to a heat treatment, the treatment required in any particular case varying somewhat as regards the temperature employed and duration of heating and cooling.—*February 25th*, 1926.

MEASURING AND TESTING INSTRUMENTS.

236,187. June 5th, 1925.—IMPROVEMENTS IN OR RELATING TO FERRARIS ELECTRIC METERS, Société Genevoise d'Instruments de Physique, of 8, Rue des Vieux-Grenadiers, Geneva, Switzerland.

A short-circuiting ring, which can be displaced along a branch



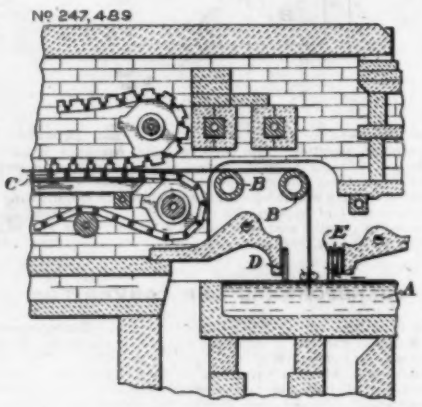
of a pole piece, a provided for adjusting the phase displacement between the fluxes of the current circuit and the voltage circuit. The meter also has a metal tongue in the air gap between the branch of the pole piece and the movable disc of the meter, for adjusting the asymmetry of the fluxes. The branch A of the

pole piece carries a short-circuiting ring B rigidly attached to an adjusting rod C, which is in the form of a rack and engages with a pinion D pivoted upon the pole piece, by means of which pinion the rack may be moved downwards in order to adjust the position of the short-circuiting ring for altering the phase displacement between the flux of the current circuit and that of the voltage circuit. Between this ring B and the branch A there is a tongue-shaped member E, the upper part of which is bent over at right angles to the remainder in order to act upon the flux issuing from the branch A. A hole is pierced in this tongue through which passes the screw F, about which the tongue may be oscillated by moving its laterally extending part G. Between the tongue and the rack is a member H, which is gripped beneath the heads of the two set screws of the pole piece. When the screw F is slackened, it is possible to release the rack and to actuate the pinion D in order to raise or lower the ring B and by exerting a slight effort upon the extension G to alter the position of the tongue E. These positions are limited by the lateral branches of the ring B. It is to be noted that as the member H presses upon the tongue the latter will always be held in place sufficiently firmly for an alteration of the position of the ring to have no effect upon the position of the tongue even if the screw F is slackened.—*February 25th*, 1926.

MISCELLANEOUS.

247,489. September 23rd, 1925.—Drawing Sheet Glass, *F. W. Golby*, 3, *John-street, Bedford-row, London, W.C.* 1.

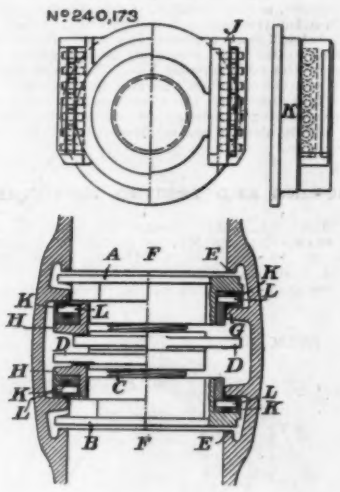
This invention is concerned with the continuous drawing of sheet glass, and aims at increasing the rate of production. Molten glass is drawn up out of the pot A over the rollers B B on to the travelling table C, the band of glass being initiated by means of a "bait." After it has once been started it is important



that the sheet of glass should not be subjected to further heat, or it may tear apart. The inventor consequently arranges water-cooled baffles D and E on the faces of the lip-tiles, to screen off any currents of hot gases. It will be seen that in the case of the baffle E there is a hollow through which the gases may pass, but they are so directed that they do not impinge on the glass being drawn.—*February 18th*, 1926.

240,173. September 18th, 1925.—Improved Sliding Valve, Schäffer and Budenberg Gesellschaft mit beschrankter Haftung, of Magdeburg, Buckau, Germany.

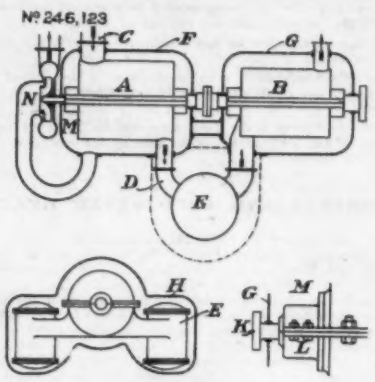
The valve plates A and B are joined together by a screwed spindle C, on which there is a lever D, which is connected with the slide spindle in any suitable manner, so that by turning or pulling the slide spindle the lever D is pulled up, and the plates A and B which are provided with inside threads to fit the spindles C,



are pulled off their seats E. By still further turning or pulling of the sliding spindle, an upward movement of the plates A and B occurs, and the passage F is opened. To reduce friction in this upward movement between the plate A and B and the abutment or guide G, the valve plates or their holder H are provided with roller bearings. These roller bearings consist of a case J in which several rollers K are arranged on spindles in an appropriate manner.—*February 25th*, 1926.

246,123. December 31st, 1925.—Improvements in Turbo-Compressors, Aktiengesellschaft Brown, Boveri et Cie., of Baden, Switzerland.

The illustrations show the invention as applied to the turbo-compressor of a refrigerating plant. The compressor comprises two units or stages A B in series. C is the suction branch and D the connecting pipe to an intercooler E. F and G are casings in which the units or stages A and B are enclosed, and in which a slightly reduced pressure, as compared with that of the atmosphere, is maintained. The casings F G may also enclose auxiliary apparatus, such, for example, as the intercooler E, by means of enlargements H. The stuffing-box L is made reasonably tight, and this considerably simplifies its construction as compared with one designed to attain absolute tightness. Leakage from the stuffing-box L is intercepted by the reduced pressure chamber M formed by the casing G, thereby preventing the gases from reaching the surroundings to be protected. The reduced pressure can be obtained in any desired



manner—for example, by fans N, ejectors or chimneys, which convey the gases away.—*February 25th*, 1926.

248,308. September 24th, 1924.—Packing for Piston Valves, J. L. Brunton and Brunton Brothers, Ltd., 17, St. Stephen's House, Victoria Embankment, London, S.W. 1.

It appears that this packing is intended for service on the pistons of hydraulic operating valves. As will be seen from the

drawing, the bottom of the packing groove is inclined and the leather packing A does not fill the groove. On the opposite side of the piston to the valve ports there is a solid filling piece B in the groove. When the valve is moved the packing piece A tends to ride up the inclined bottom of the groove, and makes a tight joint in the valve casing.—*February 24th*, 1926.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME and PLACE at which the meeting is to be held should be clearly stated.

TO-DAY.

Diesel Engine Users' Association.—Caxton Hall, Westminster, London, S.W. 1. Paper, "Industrial Tests on Internal Combustion Engines," by Mr. W. A. Tookey. 3.30 p.m.

Institute of Marine Engineers.—85-88, The Minories, Tower Hill, London, E. 1. Annual meeting. 6.30 p.m.

Institute of Metals: Sheffield Local Section.—Applied Science Department of the University, St. George's-square, Sheffield. Joint meeting with the Sheffield Silver Trades Technical Society. Paper, "Silver from Mine to Market," by Mr. E. A. Smith. 7.30 p.m.

Institution of Civil Engineers: Birmingham and District Association.—Chamber of Commerce, New-street, Birmingham. Paper, "Water Supply from Underground Sources," by Mr. J. E. Dumbleton. 6 p.m.

Junior Institution of Engineers.—39, Victoria-street, London, S.W. 1. Paper, "Modern Methods of Cast Iron Pipe Manufacture," by Mr. T. E. Dimbleby. 7.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders.—Literary and Philosophical Society's Lecture Theatre, Newcastle-upon-Tyne. Paper, "Hydro-mechanical Marine Gearing," by Mr. James Richardson. 7.30 p.m.

Railway Club.—65, Belgrave-road, London, S.W. 1. Paper, "Signals and Signalling," by Mr. C. N. Anderson. 7.30 p.m.

SATURDAY, APRIL 10TH.

Institute of British Foundrymen: Lancashire Branch.—College of Technology, Sackville-street, Manchester. Annual general meeting. Paper, "Patternmaking, and its relation to Design and Foundry Practice," by Mr. R. W. Kemlo. 3 p.m.

Junior Institution of Engineers.—Visit to the works of the South Metropolitan Gas Company, East Greenwich. 2 p.m.

MONDAY, APRIL 12TH.

Institution of Automobile Engineers: Birmingham Centre.—Birmingham and Midland Institute, Birmingham. Lecture on the L.G.O.C. methods of omnibus repair, by Mr. G. Rushton. 7 p.m.

Institution of Mechanical Engineers.—Storey's-gate, Westminster, London, S.W. 1. Graduates' Section meeting. "Some Factors Affecting the Speed of Passenger Trains," by Mr. F. C. Johansen. 7 p.m.

Institution of Structural Engineers.—Piccadilly Hotel, London, W. 1. Annual dinner. 7 for 7.30 p.m.

Institution of Structural Engineers: Midland Counties Branch.—Chamber of Commerce, New-street, Birmingham. Paper, "The Laying of the Tansa Pipe Line in India," by Mr. J. Bickley. 7.30 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, London, W. 1. General meeting. 5 p.m.

Society of Engineers.—Geological Society's Rooms, Burlington House, Piccadilly, London, W. 1. Paper, "An Inquiry into the Ugliness of Engineering Structures," by Mr. H. H. Creswell. 5.30 p.m.

Surveyors' Institution.—12, Great George-street, London S.W. 1. Paper, "The Law of Property Acts, 1922 and 1924: Copyholds, Manors, &c.," by Mr. H. E. Sherwin. 8 p.m.

MONDAY TO SATURDAY, APRIL 12TH TO 17TH.

Optical Convention, 1926.—Imperial College of Science and Technology, Imperial Institute-road, London, S.W. 7.

TUESDAY, APRIL 13TH.

Institute of Marine Engineers.—85-88, The Minories, Tower Hill, London, E. 1. "Double-acting Oil Engines," by Mr. W. S. Burn. 6.30 p.m.

Institution of Automobile Engineers: Coventry Centre.—Broadgate Café, Coventry. Paper, "Automobile Gears," by Mr. H. E. Merritt. 7.30 p.m.

Institution of Civil Engineers.—Great George-street, London, S.W. 1. Paper, "The Influence of Electric Welding in the Design and Fabrication of Plant and Structures," by Mr. J. Newell Reeson. 6 p.m.

Institution of Electrical Engineers: Scottish Centre.—Royal Technical College, George-street, Glasgow. Paper, "Design of Electrical Plant, Control Gear, and Connections for Protection Against Shock, Fire and Faults," by Mr. H. W. Clothier. 7.30 p.m.

Institution of Engineers and Shipbuilders in Scotland.—39, Elmbank-crescent, Glasgow. Paper, "Dunlop Tyres and their Uses," by Mr. A. Healey. 7.30 p.m.

Institution of Petroleum Technologists.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Paper, "The Oilfields of the Maracaibo Basin," by Mr. Campbell M. Hunter. 5.30 p.m.

Manchester Geological and Mining Society.—Queen's Chambers, 5, John Dalton-street, Manchester. Papers: "A Description of a Fish Spine Found in the Coal of the Arley Seam at Cleworth Hall Colliery, Tyldesley," and "The Occurrence of a Crystalline Deposit in a Bullion from the Roof of the Lower Mountain Mine, Burnley," by Mr. J. Lomax. 4 p.m.

WEDNESDAY, APRIL 14TH.

Chemical Engineering Group.—Burlington House, Piccadilly, London, W. 1. Joint meeting with the Institution of Chemical Engineers. Paper, "The Beet Sugar Industry," by Mr. J. Kwantes. 8 p.m.

Institution of Civil Engineers.—Great George-street, London, S.W. 1. Informal meeting. Discussion on "The Young Engineer: His Training and Prospects," introduced by Mr. G. W. Tripp. 6 p.m.

Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, London, W.C. 2. Wireless Section meeting. "The Rugby Radio Station of the British Post Office," by Mr. E. H. Shaughnessy. 6 p.m.

Institution of Electrical Engineers: South Midland Centre.—The University, Edmund-street, Birmingham. Discussion on "The Government Electricity Bill." 7 p.m.

Liverpool Engineering Society.—9, The Temple, Dale-street, Liverpool. Paper, "The Properties and Engineering Uses of Stainless Steel," by Mr. R. Waddell. 8 p.m.

THURSDAY, APRIL 15TH.

Institution of Automobile Engineers.—Watergate House, Adelphi, London. W.C. 2. Graduates' meeting. Lecture by Dr. W. R. Ormandy on his recent continental motor tour in a 30 horse-power Vauxhall car. 7.30 p.m.

Institution of Automobile Engineers.—Cavendish Café, Cornmarket, Derby. Derby graduates' meeting. Paper, "Problems of the High-speed Optical Indicator," by Mr. A. A. Rubbra. 7.30 p.m.

Institution of Civil Engineers: Birmingham and District Association.—Visit to Coombs Wood Collieries and Netherton Ironworks of N. Hingley and Sons, Ltd.

FRIDAY, APRIL 16TH.

Institution of Engineering Inspection.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Paper, "Petroleum and its Products," by Mr. J. Venn Stevens. 7.30 p.m.

Institution of Mechanical Engineers.—Storey's-gate Westminster, London, S.W. 1. Paper, "Modern Development of Paper Mill Plant," by Messrs. W. Worby Beaumont and L. N. Burt. 6 p.m.

Institution of Municipal and County Engineers.—Town Hall, Manchester Old-road, Middleton. North-Western District meeting. 11 a.m.

Junior Institution of Engineers.—39, Victoria-street, London, S.W. 1. Lecturette, "Automobile Lighting, Starting, and Ignition," by Mr. T. L. Allison. 7.30 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, London, W. 1. Discourse, "The Quest for Economic Plants," by Dr. A. W. Hill. 9 p.m.

SATURDAY, APRIL 17TH.

Institution of Civil Engineers.—Students' visit to the Littleton Reservoir of the Metropolitan Water Board.

TUESDAY, APRIL 20TH.

Institute of Marine Engineers.—85-88, The Minories, Tower-hill, London, E. 1. "Bearing Metals," by Mr. W. Griffiths. 6.30 p.m.

Institution of Automobile Engineers.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Paper, "Experiments on Laminated Springs," by Mr. H. S. Rowell. 7.30 p.m.

WEDNESDAY, APRIL 21ST.

Institution of Municipal and County Engineers.—Town Hall, Melksham, Wilts. Southern District meeting. 11 a.m.

THURSDAY, APRIL 22ND.

Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, London, W.C. 2. Seventeenth Kelvin Lecture, "The Mechanics of the Electric Field," by Sir J. J. Thomson. 6 p.m.

FRIDAY, APRIL 23RD.

Institute of Metals: Swansea Local Section.—Metallurgical Department, University College, Singleton Park, Swansea. Annual general meeting. 7.15 p.m.

Institution of Mechanical Engineers.—Storey's gate, Westminster, London, S.W. 1. Informal meeting. Discussion on "What Our Foreign Competitors are Doing," introduced by Mr. F. J. Hookham. 7 p.m.

MONDAY, APRIL 26TH.

Institution of Structural Engineers.—Abbey House, Victoria-street, London, S.W. 1. Students' meeting. Discussion on "Theory *versus* Practice," opened by Mr. Ewart S. Andrews. 6 p.m.